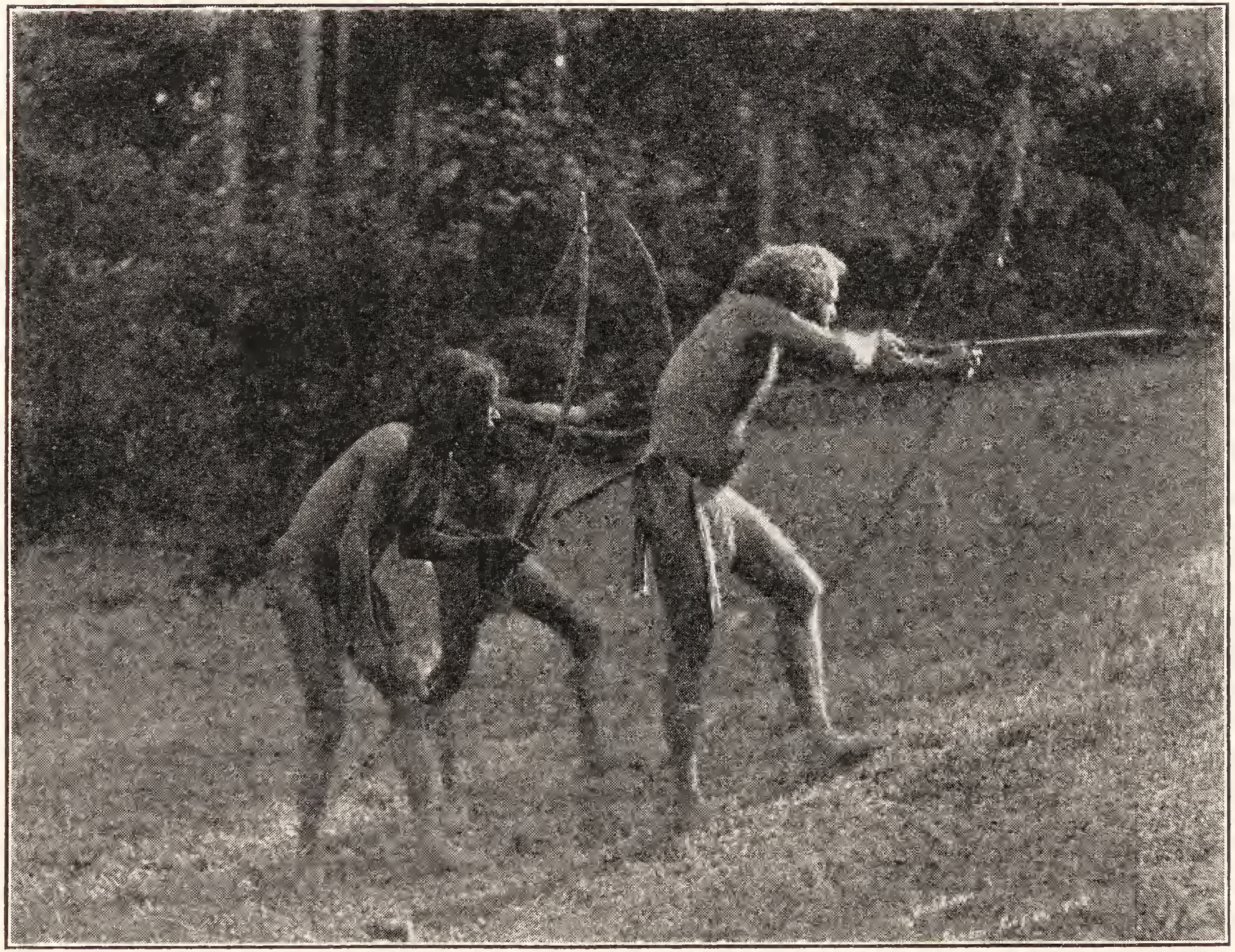
THE PEDIGREE OF THE HUMAN RACE

H. H. WILDER



FRONTISPIECE. Group of Veddahs, the aboriginal inhabitants of the island of Ceylon, and still living in the extensive forests in the south of that island.

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BY

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TO MY WIFE

INEZ WHIPPLE WILDER

"Multum restat adhuc, multumque restabit, et post multa saecula nemini occasio praecludetur aliquid adjiciendi."

SENECA.

PREFACE

In essaying to write of the Pedigree of the Human Race the author feels that he must write only as a professional zoölogist, investigating the history of a single animal species which has become universally distributed and which, in the matter of the nervous system, has far surpassed the powers of all other species.

It is thus primarily the Natural History of that Mammalian Order known as the Primates, and although, owing to the supremacy of the single living member of the Genus Homo, this Order has long been assigned the highest position among the Mammalian Orders, yet, anatomically considered, it is very generalized, retaining many primitive characters, and by no means as specialized as many others. As the pedigree of certain of these, like the horse, the camel, and the elephant, has been quite satisfactorily traced by the aid of information furnished by the bones of their extinct members, the pedigree of man may now be traced by the same methods. All the way through the book we have imagined the decisions of a hypothetical scientist on the planet Mars, to whom have been brought many sorts of the animals from the earth, preserved in alcohol, among which are several specimens of man, of all ages and races entirely nude and stripped of all extraneous results of civilization, and to him are referred all questions which may at any time seem too much prejudiced or too personal, and as he may not be considered even a Primate, he will be able to decide without human prejudice, and thus have a great advantage, to which we, as poor human beings, cannot attain. To him may be referred writer and reader alike, for both will have much need of it. This Martian scientist has helped us all the way through, and in no place more than in the consideration of the various living races, which both he and the author, when in his fairer moods, looks upon as merely the varieties of a single species, the main differences of which have been retained in their vats of alcohol.

Perhaps the most radical of the changes is the use of the Family Hominidae to include the tailless anthropoid apes and the various related species that have been recently unearthed in the soil. It may be useful to make a Sub-Family Homininae, to include man past and present, comparable to the Hylobatinae and Pongiinae, but there are certainly no structural differences sufficient to make a different Family of them. Even a definite separation of Sub-Families is hard to accomplish, and the distinctions between these may be eventually lessened when the returns are all in.

But this is only a preface, and it is unfair to the reader to bring

him into an argument in this place. It is to be hoped, however, that he will find in the book itself the author's views, more or less aided by his Martian friend.

In closing this preface it is my pleasant duty to state that I have many friends who have helped me in compiling this book, and I would like especially to mention a few of them. The beautiful photographs of living Hominidae, Sub-Families Hylobatinae and Pongiinae, were taken for the New York Zoölogical Society by their official photographer, Mr. Elwin Sanborn. Dr. Raymond Z. Ditmars is also involved in this, as he first acceded to my request for photographs of the large anthropoids, and referred me to Mr. Sanborn. The little Indian boy, who figures here as an example of *Homo sapiens*, was taken at the Tewa Pueblo, N. M., by Miss Harriet Andrews, who gave me this photograph several years ago. In the lapse of years I have lost track of the photographer, but if this should ever come to her notice, I should like to express my thanks. I am reserving for the last, my most especial thanks to the well-known African explorer, Mr. Carl Akeley, through whom I procured the fine gorilla head, "The Old Man of Mikeno." This was modeled on the spot by Mr. Akeley himself, who had just shot the specimen, and from this model a cast in bronze was made. This, although not a direct photograph from a living gorilla, is at present the best thing now obtainable, for it is quite impossible to photograph a living adult gorilla by any means now known. A photograph of a gorilla may be taken when one has just been killed, but such forms always have a dead look, and do not at all represent the living animal. This has been accomplished by Mr. Akeley, who combines the unusual combination of gifts, a sculptor and a good shot. Another quality, perhaps equally rare with the others, is that he is very generous, and it is owing to this quality, no less than to the others, that I am able to reproduce this photograph here.

H. H. W.

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CHAPTER I.

OUR LIVING MAMMALIAN RELATIVES

1. The Genesis of Man. From the standpoint of the evolutionist Man with his national and racial affinities, with his towns and cities, his civilization and his laws, his literature and his art, is an animal species which has succeeded preëminently in the Struggle for Existence, and has become almost universally distributed over the habitable surface of the earth. Although in degree surpassing all other similar attempts, in kind this instance is but one of many, and does not differ essentially from the like success of many other animal and plant species, both in past and present times. If the mere number of individuals and the extent of the earth's surface occupied be taken as the measure of success, then the present supremacy of Man is not greater than that of numerous other species, but since the organ selected for specialization has happened to be the brain, he has gained mental attributes, which have enabled him to modify his environment and to control both natural forces and other creatures to an extent never before attained. More than any other animal, Man has already produced profound changes in the aspect of the lands he has occupied; he has leveled hills, bored mountains, and changed the course of rivers; without undergoing any bodily modification he has gained the power of transporting himself and his possessions over both land and sea with great rapidity, and has already achieved his initial success in journeying through the air. All this he has been enabled to accomplish through an intelligent control of the inanimate forces of nature, many of which have never been utilized by any other animal species. Not the least of his triumphs, too, is his control over other animal and plant species, which he can distribute and cause to multiply, or limit and exterminate, in accordance with his

desire and can even modify their bodily form or their instincts, in order to furnish him with some real or supposed advantage.

When, however, all this has been said concerning the supremacy of Man; and when, in addition, his advance on the development of his higher intellectual and spiritual life has been taken into account, he still remains, as was stated at the beginning, an animal species, subject, like all the others, to the laws of development; like all the others, a product of Evolution. Although the study of Man at his best, among the highest civilization and surrounded by the highest culture, masks the true state of things, and disguises his animal affinities, these latter become easily apparent if we turn to the more primitive human races, and thus eliminate the long period of cultural development that has been interposed between them and ourselves. Among such people not only do many of the artificial distinctions fade away, but we find in the minds of the people themselves a natural acceptance of their kinship with the other animals. In the folk-lore of all primitive peoples animals play almost an equal part with men; they converse with them; they are addressed by such terms of kinship as "brother" or "grandfather," and many a tribe is proud to trace from them its traditional descent. Especially does the distinction between men and other animals disappear in the countries inhabited by the great man-apes, where it also happens that the human inhabitants are among the most primitive of modern races, and where, therefore, the gap between Man and animals is the least that now exists on the earth. Everywhere in such places these great apes are considered to be simply wild men; are denominated as such in the native languages, and appear thus in the local folk-lore and popular stories.

Still, if we consider the present day only, and ignore what we already know of the past, we must acknowledge the existence of an extensive gap between even the lowest Man, with his articulate speech and his deftness in the use of tools,

and the highest ape, with but a few vocal sounds, and with his clumsy grasp and uncertain use of sticks and other rough objects. Only by the study of the remains of past epochs, the data for which are becoming every year more complete, can this gap be satisfactorily bridged over, and the slow and gradual steps of this process of man-making be determined.

Investigated by means of such data, and passing backwards far beyond the bounds of recorded history, we see Man gradually losing the cloak of civilization which he has formed about him, equipped with fewer and cruder implements, and living in ruder shelters. Iron weapons give place to those of bronze or copper; these to still cruder ones of stone; and as we go ever further into the past, even the art of shaping these becomes gradually lost, until we find man employing the chance forms which a single rude blow may have produced. And accompanying this gradual backward view of the external surroundings of the creature we are studying there come changes in his bodily form and proportions. In close correspondence with the gradual inferiority of the implements, as we trace the history backwards, comes an equally gradual loss of the finer adjustments of the hands and fingers; the shape of the head becomes more bestial, the brow low and overhanging, the jaw heavy and chinless, the legs curved and the back bowed. The deft hand of modern Man, and the brain that controls it, have both been gained by age upon age of work and experiment, at first in the crudest sort of way with the crudest of tools. The being with the man-making possibilities has gained his present position step by step, and his isolation from the rest of the brute creation is now due to the extinction of the intermediate stages.

Thus Man, in spite of his vast progress, a progress which seems to advance with a continually increasing rapidity, may still be viewed as an animal species, and as such has a definite relationship to certain other forms. This history, of which the portion just outlined forms but a very small

part, involves the greater problem of the course of development of animals in general, and is the task of the zoölogist rather than that of the anthropologist in the strict sense. However, the main outlines of this problem may be presented here in order to make the history of Man more complete. Taking both the past and the present into consideration the problem will include the *Genesis of Man*, or *Anthropogeny*, as well as the relationship of Man and his nearest animal relatives to each other: the problem called by Professor Huxley, "Man's place in Nature."

2. Man as a Mammal. Judged by his bodily features Man is a typical representative of the Class of Mammalia, that Class of vertebrates which is roughly characterized by the presence of mammary glands and an external coat of hair. He is, moreover, a rather primitive member of that group, as he lives upon the surface of the earth, is an omnivorous feeder, and is possessed of the original five digits on both pairs of limbs. He is far less specialized in general form than the whales and the manatees, which have become wholly aquatic; than the bats, which have become fitted for flight; or the moles, with their subterranean life. His hand and foot are much less modified than those of the groups of hoofed animals; his dentition is far more primitive than that of the rodents. These primitive characters he shares with his nearest mammalian allies, the apes, monkeys, and lemurs, animals the similarity of which to each other has long been recognized, and which, together with a few others, Linnaeus united to form his group of the "Primates," signifying thereby that they were the princes of the animal kingdom, the primates of the realm. This name is, however, of still greater significance in another sense, never thought of by Linnaeus, that of being *primitive*, for with the exception of the Insectivora, the Primates are perhaps the most primitive and the least modified of all existing mammals. Early in their career the members of this group seem to have

become arboreal, and as an adaptation to this environment, gained prehensile paws, with an opposable first digit, either on the fore, or the hind foot, or on both, and were thus enabled to seize hold of small objects and bring them to the direct scrutiny of their sense-organs. This power in its turn, by furnishing the sense-organs with constant stimuli of a more exact nature, seems to have been the indirect cause of a rapid increase in the size of the brain, a change which can be observed to some degree in almost the earliest representatives of the group, and which was destined to gain for one of its members the supreme position in the world. As a secondary result of this power came the reduction of the snout, which was now no longer necessary as an exploring organ, and this process ended in the formation of the flat face so characteristic of Man and the present-day monkeys. In these aspects the modern Primates have all become specialized, some highly so, but since the organ which has been principally concerned, the brain, is an internal one, its development has not necessitated any great modification of the external form, except that of the head and face.

The relative position of this group to the other mammals is best considered by first reviewing the Class of Mammalia in general, and then by taking up its subdivisions as represented by the living Fauna.

3. The Subdivisions of Mammals.[1] With respect to their structure, and more especially their developmental relations, the Class of mammals may be subdivided into the following three groups:—

(a) *Monotremata.* These, the so-called "reptilian mammals," possess but two living representatives, the duck-bill

[1] Two works of the first importance upon mammals, emphasizing the anatomical differences of the various groups, are Weber's "Die Säugetiere" and Flower and Lydekkers's "Introduction to the study of Mammals" (A. and C. Black, London, 1891). The former is the better and more complete, but the latter has for most readers the advantage in language. For exclusively

(*Ornithorhynchus*) and the spiny ant-eater (*Echidna*), both found only in Australia and the neighboring islands. They alone among the mammals lay eggs; and these are much like those of reptiles, slightly oval in shape, and with a flexible shell. The young are very immature when hatched, and are fed by a primitive type of mammary gland, which is scarcely more than an enlargement of the integumental glands that normally occur in that place. The secretion is obtained by licking the hairs and by sucking at little tufts that can be taken into the mouth. In many points of structure, such as the composition of the shoulder-girdle and the cloacal relationships, the monotremes closely resemble reptiles. Both species are without teeth when adult, but this is plainly a secondary condition due to special methods of life, since the young *Ornithorhynchi* possess for a time functional teeth of a type similar to those of the allied extinct group of the *Allotheria* (*Multituberculata*), a very ancient group of reptilian mammals.

(b) *Marsupialia.* These are the "pouched mammals," like the opossum and the kangaroo, in which the young are born in a very immature state and nourished within an integumental pouch (marsupium), situated upon the abdomen of the mother. The mammary glands open along the inner wall of this pouch by means of nipples, definite and typical in shape though in some species irregular in their

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North and Central American animals the works of D. G. Elliot (Field Columbian Museum, Chicago, 1901 and 1904) are excellent. The standard work on the Primates alone is the recent great work of this same author (Elliot) in three volumes, "A Review of the Primates," published by the American Museum of Natural History, New York, 1913.

Another convenient work on Primates, which includes the principal forms of the entire world, is the "Handbook to the Primates" by H. O. Forbes (2 vols.) in Allen's Naturalist's Library; London, 1894, and there is a similar one by R. Lydekker on the Marsupials and Monotremata in the same series.

The manuals of Osborn (1910) and Scott (1913) are written from the paleontological standpoint, and are cited under the literature of the second chapter. They are fundamental for the study of the evolution of the present mammalian groups.

arrangement. In other points of structure these animals are much like placental mammals, and are not reptilian like the monotremes. Their most primitive character, other than their developmental relations, lies in the number of their teeth, which, except in the more specialized ones, is somewhat greater than in the placentals, and more nearly corresponds to the condition in the Therapsida, an extinct reptilian group, assumed by many to be ancestral to the mammals. The assertion that the marsupials are more primitive than the placental mammals, although until recently a universal doctrine, is based largely upon the anatomical structure of the urino-genital system of the female, and the relation of the embryo to the uterus. There are two distinct genital tubes (Müller's ducts), which, although divided into the usual mammalian subdivisions of oviduct, uterus, and vagina, open separately into a urino-genital sinus, still quite as in the lower vertebrates. The chorion, which surrounds the embryo, although not covered with a shell, as in monotremes, is still not closely adherent to the uterine wall, and, except in one or two cases (*Phascoloarctus*), is not reached by the allantois. There is thus no placenta, and the young are born in an immature condition and pass the remainder of their development in an external pouch, the marsupium, where they are fed with milk but by a process in which, for a long time, they are wholly passive.

These are evidently primitive characters, but the two important testimonies of geological appearance and geographical distribution suggest for them rather a late specialization. The earliest known genuine marsupials occur in the Oligocene, long after many lines of placental mammals have become considerably specialized, and to assert that the still earlier mammalian forms of the late Mesozoic were marsupials is to make a statement for which there is no direct evidence.

The geographical distribution of the marsupials is a peculiar

one for, with the exception of the opossums (*Didelphys*), an American genus, they are wholly confined to Australia and its associated islands, while these same countries at the time of their first exploration by the English were entirely lacking in placental mammals with the exception of a few species of bats, and a single species of wild dog. As the first of these may easily have reached this region from the adjacent islands on their own wings, and as the second has apparently run wild from a form domesticated by the aborigines, the entire Australian continent must have been primarily stocked with monotremes and marsupials alone, while placental mammals were never introduced. Since these latter mammals are very successful there when once brought in, as in the well-known case of the rabbits introduced by the English colonists, this singularity in the original distribution remains to be explained otherwise than by climate, and may have some important bearing upon the early history of mammals in general. A theory early suggested was to the effect that the marsupials were developed prior to the placentals, and that at the time of their universal distribution the Australian continent formed a part of the Asiatic mainland and thus shared in the possession of a marsupial fauna. The rise of the placentals, with their more formidable carnivorous members, succeeded, throughout the rest of the world, in exterminating the marsupials, with the exception of the opossums, the American genus, but that, before the placentals had migrated as far as Australia, this latter territory had become severed from Asia by the present straits, and was thus preserved for the marsupials alone. It is certainly true that in some way the marsupials were introduced into the Australian province while the placentals were excluded, but that this condition was brought about in the way suggested by the above theory can no longer be believed. As above remarked, the marsupials were, in their appearance, either contemporaneous with, or probably later than, the placentals; local geological evidence, also, goes to

show that the marsupials were introduced into Australia very late (perhaps not earlier than the Pleistocene), and at a time when the Placental mammals were elsewhere nearly as widely distributed and as highly differentiated as at the present time. Since, now, there are no placental remains in Australia, and only late marsupial ones, it must be assumed that for some reason Australia remained for a long period free from mammals of any kind and that when the invasion did occur, it was participated in by marsupials only.

(c) *Placentalia.* This group includes all the more commonly known mammals, and forms much the largest division of the Class. Its fundamental characteristic, as expressed in the name, is the development of the young within the maternal uterus by means of a placenta, an organ formed by a part of the uterine wall, in combination with a portion of the fetal allantois. The teeth are fewer in number than in the more primitive of the marsupials, and exhibit a wide range of specialization, corresponding to the varied environments to which they have become adapted. The carnivorous forms, like the cats, have teeth shaped for cutting and tearing; herbivorous forms, like the antelopes and horses, have teeth with flat, grinding surfaces; those that subsist on roots, nuts, and seeds, like the beaver, the squirrel, and the rat, have sharp, gnawing teeth, shaped like chisels; insect feeders, like the mole and certain bats, have teeth furnished with numerous sharp points; and those that feed mainly upon fruits and grains, with the occasional use of flesh foods, like the monkeys and apes, have a combination of flat, crushing teeth with some that are fairly well fitted for cutting and tearing.

In uterine and cloacal relations the placentals are not so distinctly separated from the marsupials as seem at first sight to be the case. In some forms (e. g. aardvark, elephant, some rodents, a few bats) there are two distinct lateral uteri, which open into a common vagina by separate mouths (*ora uteri*); in many others the two uterine elements are

quite distinct throughout the most of their course, uniting merely to form a common opening into the vagina (*os uteri*). A single median uterus is found only in the Primates and a few other cases, and thus the Placentalia in general scarcely merit the term "Monodelphia" (one uterus) by which they are often designated, in order to distinguish them from the "Didelphia," an alternate term for the Marsupialia. If it be also taken into account that in a few of the marsupials (e. g. *Phascoloarctus*) a portion of the allantois comes in contact with the wall of the maternal uterus, thus forming a genuine, though very small and ineffective, placenta,[1] the distinction between these two groups becomes a slight and not very fundamental one, while the great differences that exist between both, taken together, and the reptiloid group of the monotremes, becomes the more emphasized. It thus better expresses the true relationships that exist between the various living mammals if they be divided into two, rather than three, main subdivisions, the Sub-Classes of *Prototheria* and *Eutheria*, the first to include the monotremes alone, the other the remainder of living mammals. These, with their subdivisions, may be put into the form of a synopsis, as follows:—

4. Synoptical Classification of Living Mammals.

Class: MAMMALIA.

Sub-Class I. Prototheria.

This subdivision includes the reptilian mammals, that is the transition forms between true reptiles and the typical mammals of the present day. As may be imagined from the stage of development which these represent, the group is a very ancient one, in great part pre-Eocene, and is very imperfectly known to us, as the records consist mainly of fragments of bones and teeth, quite incomplete. They were all small animals, as is usually the case with the early representatives of all groups, and, judging from the jaws and teeth,

[1] For this cf. R. Semon: Die Embryonalhüllen der Monotremem und Marsupialier, in Semon's Forschungsreise: Bd. II, 1894, pp. 25–28.

some of them must have been so closely related to certain contemporaneous reptiles, the Therapsida, that no distinct line of separation could be made. The more primitive ones may be assumed to have possessed a coat of scales, between which there developed groups of hairs. They probably laid eggs, and it is also likely that at first they were without milk glands. The later forms must gradually have lost the coat of scales, while with the increasing importance of the hairs, associated integumental glands seem to have developed. Certain of these latter, situated on the ventral side of the body, developed secondarily the function of furnishing a food for the nourishment of the young, the typical mammary glands, but these, within the limits of this group, are always in a very primitive form.

Of this entire Sub-Class there are but two living representatives, closely related to each other, and apparently representing an aberrant line. These are placed in the following group, with the value of an Order:—

Order: *Monotremata* (*Ornithorhynchus; Echidna*).

Sub-Class II. Eutheria.

These are the typical mammals, and include all the living species, with the exception of the two monotremes, just given. The two subdivisions of the group, marsupials and placentals, are not very far apart, and are structurally much more like each other than either is like the monotremes. Both groups possess definite mammary glands, and the most fundamental distinction, that of the presence or absence of a placenta, is in part obliterated by the recent discovery that at least one of the marsupials (*Phascoloarctus*) develops a small placenta, of functional value, though for a brief time. The two groups are conveniently retained, however, although their close relationship to each other and the distance separating both from the monotremes must be borne in mind.

Group 1. Marsupialia (=Didelphia) (for definition see § 3).

Order 1. *Polyprotodontia* (more primitive marsupials, like the opossum, with a large number of incisor teeth, usually $\frac{5-5}{4-4}$).

Order 2. *Diprotodontia* (Marsupials with a specialized dentition, and but two incisor teeth in each jaw, $\frac{1-1}{1-1}$).

Group 2. *Placentalia*=Monodelphia (for definition see § 3).

(I) *The more primitive Orders, with five digits and a well-developed clavicle; omnivorous feeders, living on fruits, nuts, seeds, insects, and small game.*

Order 1. *Insectivora* (European hedgehogs; shrews; moles).

Order 2. *Primates* (lemurs; monkeys; apes; Man).

Order 3. *Rodentia* (squirrels; beavers; rabbits; rats; mice).[1]

Order 4. *Galeopithecoidea* (a single species from India; *Galeopithecus*, the "flying lemur").

Order 5. *Chiroptera* (bats).

Order 6. *Edentata* (sloths; armadilloes; ant-eaters).

(II) *Carnivorous forms, more or less modified. Some are adapted to live in mid-ocean and are extremely specialized.*

Order 7. *Carnivora* (bears; wolves; cats; weasels).

Order 8. *Pinnipedia* (walrus; seals).

Order 9. *Cetacea* (porpoises; dolphins; whales).

(III) *Herbivorous forms; digits tipped with hoofs, and usually reduced in number* (="*Ungulata*").

Order 10. *Hyracoidea* (a single Genus of small mammals (*Hyrax*), living among the rocks in W. Asia and S. Africa, the most primitive of living ungulates).

Order 11. *Proboscidea* (elephants).

Order 12. *Sirenia* (manatee; dugong; large marine creatures that live near the coasts and feed on sea-weed).

Order 13. *Artiodactyla* (ungulates with an even number of digits, 4 or 2; e. g., hippopotamus; deer; sheep; oxen; camel).

Order 14. *Perissodactyla* (ungulates with an odd number of digits, 5, 3, or 1; e. g., rhinoceros, tapir, horse).

[1] According to a very recent viewpoint the rabbits and hares, formerly the Sub-Order Duplicidentata of the Order Rodentia, are not rodents at all, because of the second pair of upper incisor teeth, and many other anatomical differences, but form a separate Order, the "*Lagomorpha*," whose close resemblance to the Rodentia is due to similar habits, a case of "analogical resemblance" like many cases among the Marsupialia, which resemble certain Orders of placental mammals. Still, except by specialists, they are best considered rodents, although their dissimilarity to the rest should be constantly borne in mind.

5. The Separate Orders of Division (I) of Placental Mammals. The six Orders comprising this group of placental mammals have for us a double interest: in the first place, as they are the most primitive placentals, they are the ones principally involved in the critical discussion concerning the origin of mammals and the relationship of the various groups to one another; and, secondly, it is one of them, the *Primates*, which includes Man and his nearest relatives, the subject of this book. As represented by the forms at present surviving on the earth, and more or less isolated from one another by the extinction of intermediate forms, these six Orders may be described as follows:—

(1) *The Insectivora.* This group includes the moles and shrews of temperate climates; the European hedgehog (not the American porcupine, which is often incorrectly called a "hedgehog"); and several tropical forms from the Old World, like the "tenrec" (*Centetes*) of Madagascar, and the Tupaiidae of the East Indies. All of these animals possess well-developed clavicles, and separate ulna and radius, but the tibia and fibula are often united. The manus and pes are both typically walking feet, with raised pads arranged in the primitive order, but in the true moles, the fore paws are modified by fossorial habits. Both hand and foot possess five digits and the first digit is not opposable.

Many specialists, like Huxley and Osborn, consider the Insectivora the most primitive placental mammals now living, and thus of extreme importance in the question of the early history of mammals. The teeth, however, in recent forms, are considerably modified from the condition which we have reason to regard as primitive, and in this respect the Insectivora are less primitive than the Primates, and some others. The fusion of tibia and fibula, which occurs frequently (e. g., shrews and moles), is also a secondary adaptation. On the other hand the feet, with their typical walking pads, and the dorsal surface often covered with scales, must be regarded as especially primitive.

(2) *The Primates.* This group is essentially arboreal in habit and tropical in habitat. It includes the monkeys, apes, and Man; also the lemurs, or semi-apes, of the Old World. They possess in addition a more primitive form of dentition than in the case of

the Insectivora. The hands and feet are, however, more specialized than the primitive form found in the former Order, and become modified for grasping cylindrical objects, a modification acquired in adaptation to an arboreal life. This modification consists largely in giving the first digit an opposable character, so that it may be separated from the other four, and turned towards them; but aside from this the digits gain greatly in the power of flexion, and in curving around an object such as a tree-bough, and in a few cases (e. g., orang-utan) the bones themselves become permanently bent to facilitate this action. The walking pads are greatly reduced, and form soft cushions marked by concentric epidermic ridges to prevent slipping; and the claws become flattened, and form nails, also plainly an adaptation to an arboreal life. The opposable first digit, which gives the member the quality of a "hand," may develop on fore or hind limb alone, or on both. In a few cases, in American forms only, the tail develops a prehensile power and assists in climbing.

Aside from these very primitive characters the Primates show in various degrees a specialized development in one definite direction, namely, in that of an increase in the size of the brain, with a corresponding advance in intellect. This modification affects the bodily structure in several ways; the cranial portion of the skull is increased in all of its dimensions, length, breadth, and height; there is a tendency towards the assumption of an erect or semi-erect position and a shifting forward of the point of insertion of the vertebral column, perhaps the better to sustain and balance the heavier head; and there is a marked reduction in the size of the jaws, particularly in their length, thus shortening the snout and developing a flat face, normally held with its plane nearly vertical. These modifications give to the head and face a characteristic shape, seen in its extreme in the higher monkeys and in Man. Correlated with this flat face, perhaps as a result, perhaps as a contributing cause, comes the forward direction of the orbits, and the power of seeing the same objects with both eyes at the same time, a power not possessed at least to its full extent, in the majority of mammals. The proximity of the orbits to each other, restricts very much the size of the nasal cavities and produces a corresponding reduction in the power of the sense of smell.

(3) *The Rodentia.* This group includes the squirrels with their

more terrestrial allies, the woodchucks (marmots) and the prairie-dogs; the rabbits, beavers, porcupines, and the rats and mice. They possess clavicles (wanting in the cavies, or "guinea pigs"), paws with usually five digits, ulna and radius separate, and tibia and fibula usually so (fused in rabbits and mice). Their dentition is, however, highly specialized for the purpose of gnawing. The incisor teeth, consisting (except in the rabbits) of two in each jaw, are flat, with sharp edges, like chisels, and are constantly growing to compensate for the wear to which they are so constantly subjected. Then follows a considerable gap, without teeth, and then come the molars. In the squirrels, which in this respect are the most primitive of the group, the molars are tritubercular, while in the rest they become more or less modified, and reach in the mice a high degree of complexity. The rabbits possess a second pair of upper incisors, placed back of the others, and much reduced in size; but notwithstanding this primitive character, their molars are much less primitive than in the squirrels, and their tibia and fibula are fused, thus giving the preference for primitiveness to the last named animals.

(4) *The Galeopithecoidea.* The value of a distinct order must be given to the single animal included here, the *Galeopithecus volans*, or "flying lemur," of Farther India and the Malay Archipelago; for its structure is sufficiently distinct to separate it to this extent from all other mammals. As implied in both its popular and its scientific names, it shows some relationship to the Primates; it suggests also a close relationship to the Insectivora. Its most striking peculiarity consists of the lateral fold of skin which, as in the flying squirrel, may be spread out along each side, and serves as a parachute membrane to assist in making long leaps from tree to tree. This membrane includes both limbs and the tail, and involves even the digits as far as the claws. Most of the primitive characters emphasized in the former cases are here present; the clavicles, the five-fingered paws, and a rather primitive dentition; the ulna and fibula, however, are both somewhat rudimentary, probably in some sort of correlation to the flying membrane.

(5) *The Chiroptera.* The development of a flying membrane, as shown in the previous case, reaches its extreme in the bats, which are in this respect highly specialized, although in many other ways they retain primitive characters. Thus, aside from the

enormous lengthening to which the arm bones, especially those of the fingers, have been subjected, these parts are still quite primitive, the ulna and radius are distinct although the latter is reduced in size, and the digits are five in number, but with some phalangeal reduction. The clavicles are very large. The dentition of the more specialized group, the insect-eating bats, is considerably modified, but that of the frugivorous forms, that inhabit the tropics of the Old World, is more primitive, and the molars are often quite typically tritubercular. In the possession of a single pair of pectoral mammae and in several other external characters the bats are strongly suggestive of the Primates, in which group they were actually included by Linnaeus, but in their deeper and more fundamental characters they seem more nearly related to the Insectivora.

(6) *The Edentata.* The animals included here consist in reality of several quite distinct types, and their separation into two or three distinct Orders has been recently recommended. All are in a certain sense primitive, but rather less so than the foregoing.

The main group of Edentata (Xenarthra) is South and Central American, and the animals included are, in a way, as characteristic of this continent as the marsupials are of Australia, but without the exclusion of other forms. These South American edentates include the sloths, the armadilloes, and the true ant-eaters (not related to the "spiny ant-eater," *Echidna,* which is a monotreme). To the living fauna may be also added several extinct edentates, closely related to the foregoing and surviving almost within recent times. Thus the *Megatherium* and *Megalonyx* were gigantic sloths; the *Glyptodon,* covered with a huge carapace, was related to the armadilloes. The *Grypotherium,* a sloth-like form related to the *Megatherium,* seems to have survived almost to our time, and is supposed to have been used as a domestic animal by a race of early men. Two other groups of edentates, each probably to be given the rank of a distinct Order, are the scale covered Manidae from India and Africa, and the *Orycteropus* or "aardvark" from South Africa.

As indicated in the synopsis of living mammals the above mammalian Orders constitute a definite group and include all that may be looked upon as primitive. If we had living forms alone to examine we should be able only to form

a series of more or less probable surmises as to their true interrelationships. As it is, however, the study of the remains of their extinct allies, and the numerous discoveries among them of intermediate or transition forms, has restored for us in a measure the past history and the course of development, so that in many points the interrelations are definitely known. This phase of the work, especially as regards the Primates, will be treated more at length in the following chapter; for the present it may be more logical to examine in detail the living Primates, and their anatomical similarities and differences.

6. The Order of Primates. *The Primates are primitive arboreal mammals of small or moderate size; with prehensile pentadactylous chiridia; an opposable first digit either on the fore or the hind chiridia or both; and with a large development of brain. A few of the largest and heaviest are less arboreal and adapt themselves to the ground, and in one genus (Homo) the posterior chiridia have nearly lost their prehensile function and have become adapted to walking on a flat surface. In this genus, also, the brain reaches the highest development known. The clavicles are large, and the ulna and radius, as well as the tibia and fibula, are well-developed and separate.*

Taken in detail the characters are as follows:—

Brain. Large or very large; the increase in size affecting mainly the cerebral hemispheres. These, which become extended forwards over the orbits, and backwards over the cerebellum, as well as laterally, increase so much in the more specialized members of the Order that they may entirely conceal the other parts of the brain when viewed from above. In these forms, too, the gyri are very numerous and the sulci deep, although in this respect the Primates do not surpass certain other mammals, notably the whales, the elephants, and some of the ruminants. In the lower Primates (lemurs) the internal carotid artery, which supplies the brain with blood, enters the cranium posteriorly, as in most mammals, lying alongside the medulla and within the posterior cerebral fossa; but in the Sub-Order of Anthropoidea, the group in which this marked increase in brain is especially shown, the artery enters

the middle cerebral fossa, a point from which the brain may be more readily and advantageously nourished. These two phenomena, a large brain and an anterior position of the internal carotid artery, are thus correlated; and as the latter relation occurs even in the more primitive Anthropoidea, in which the brain is not especially large, it seems possible to view it as an important contributory cause of the later brain development.[1]

Thus, while the brain of Man was developed directly through the increase in the number and accuracy of the sensory impressions received; and while these, in their turn were due to the perfection of the grasping apparatus, which could present to the senses more details, this result seems to have been rendered possible mechanically by a more advantageous position of the feeding mechanism.

Eyeballs. These parts are large, or very large, among the lower representatives of the Order, in adaptation to a nocturnal life; they are also directed forward, and thus placed near together. This latter character persists in the higher forms; the size also is fairly large in most cases, but in the simian apes, which attain the largest size of body of any in the Order, the eyeballs are proportionately not so large.

The size and position of the eyeballs seem to be directly responsible for the next three characters.

Bony orbits. These are necessarily strengthened to support the heavy eyeballs, one result seen in all cases being the *completion of the marginal rim.* Here the deficiency on the external aspect, which is usual among mammals, is supplied by the extension of opposing processes from the frontal and jugal bones, and their articulation with each other by a suture. In the highest group of Primates, the Anthropoidea, the isthmus thus formed is carried inwards in the form of a plate, and forms a partition, complete except for the inferior orbital fissure, which separates the orbit from the temporal fossa.

Nasal fossae. These are much smaller than in most mammals and the system of scrolls (conchae) which increase the olfactory surface and thus render the sense of smell more acute, is much reduced and simplified. These reductions seem to be directly due to the enlargement of the eyeballs in adaptation to a nocturnal life, which in some cases (*Loris*, *Tarsius*) is a very marked peculiarity.

[1] J. L. Wortman, in Studies of Eocene Mammalia; Amer. Journ. Sci., Vol. XV. 1903. pp. 164–171.

There is a corresponding reduction in the acuteness of the sense of smell, which may, however, be in part compensated for by the ability to grasp an object to be investigated and bring it into direct contact with the nostrils.

Retractor muscle of the eyeball. This muscle, the *retractor bulbi*, which is commonly present and well developed in mammals, is here rudimentary or wanting. Although the exact significance of this is not clear it seems probable that this organ, which has for its function the drawing back of the eyeball into its socket, is not needed in the Primates, since the eyeball is sufficiently well protected by the greater perfection of the bony orbit. This muscle also serves to regulate the *plica semilunaris*, or third eyelid, but in the Primates this part becomes reduced with its muscle.

Teeth. The most marked peculiarity in the number of teeth is the occurrence of only two incisors in each half of each jaw (but one in the lower jaw of *Tarsius*), a smaller number than usual in mammals. There are typically three premolars and three molars, but in the Anthropoidea of the Eastern Hemisphere (including Man) the premolars are reduced to two; and in the marmosets (Callithricidae) there are but two molars. The teeth are set in continuous rows, without any marked gap, or *diastema*, and are usually of about the same length with the exception of the canines, which are generally a little longer than the others, and in a few cases are markedly elongated (*Papio*). In many cases the upper molars are quite typically tritubercular, and when otherwise show no very great departure from that type. The lower molars, while never tritubercular, are easily derived from such a form, and consist of 4–5 low cusps.

Shortening of the snout. There is a marked tendency, shown especially in the Anthropoidea, to shorten the snout or muzzle, or, more technically, to reduce the jaws in the direction of their longitudinal axis, thus tending to produce a flat face. This and the last character, the reduction in the number of cheek teeth, are closely correlated, and back of both, perhaps in a causal relation, are the two characters of the prehensile hand and the frugivorous diet. The hand, with its opposable thumb, can bring the food directly to the mouth, and relieve the snout of the function of seeking out the food itself, as is necessary among other mammals, while the soft consistency of the food tends directly to the

reduction of the size of the teeth. In many species the males develop large canines to be used as weapons, and in these cases the jaws also are heavier, producing a noticeable sexual difference.

Claws vs. Nails. In at least one of the digits the typical mammalian claw, which is curved, and laterally compressed, becomes transformed into a thin plate, flattened the other way, or dorsoventrally, thus forming a typical nail, like those of Man. This change appears to have been brought about in correlation with the Primate method of grasping the limbs of trees, which applies the pressure in such a way as to constantly flatten the terminal phalanges of the digits. In the higher Primates all of the claws become thus transformed, while in the lower members of the Order at least one digit has a nail.

Opposabl first digit. The first digit, especially that of the hind foot, shows a tendency to become separated from the rest by a considerable interval, and to have a greater freedom of motion. In this the joint especially affected is the one between the proximal end of the metacarpal, or metatarsal, and the associated carpal, or tarsal, bone (trapezium or internal cuneiforme). When typically developed the digit in question is enabled, not only to stand out markedly from the others, but to rotate in such a way as to oppose them, and, in the act of grasping a cylindrical object, to be placed along the side opposite to that in contact with the other digits. This opposition of the first digit seems to have been first acquired by the hind feet, and may well have been a pre-primate character, as it appears in certain marsupials, but in the lemurs and many of the Anthropoidea it is exhibited in the fore feet as well. In Man the opposable power of this digit in the case of the hind foot has become lost, evidently in adaptation to walking on the surface of the earth.[1]

Hair. This is in general quite thick and evenly distributed over the surface of the body as in typical mammals, but in the larger and more manlike forms it is sparse, especially ventrally, and there occur certain large areas which may be nearly or quite bare. The

[1] It may here be noted that opposability, i. e., the power of rotating the digit so as to place its distal end in opposition to the distal ends of the others, and the ability to separate the digit from its fellows, although usually connected, are two distinct things, and that while in certain primitive human races the great toe is remarkably distinct from the rest, it seems never to be truly opposable.

face and ears are often naked, but both are frequently adorned with tufts and fringes of much longer hair, the position being fairly constant in a given species. The palms and soles are absolutely hairless and are covered with conspicuous friction ridges. These epidermic structures, derived originally from rows of scales, are disposed in quite definite patterns and serve to strengthen the grasp and prevent slipping. They are thus of great importance to arboreal animals, and have maintained their existence upon the human hand and foot, although they are here softer and finer, especially in the civilized races, and the definite patterns tend to become obliterated.[1]

Mammae. These, although usually pectoral, and consisting of one or two pairs, show some departure from that plan, the number and arrangement being roughly determined by the number of young and the most convenient method of holding them while nursing. Thus *Loris* and *Galago* (Sub-order, Lemuroidea) have one pectoral and one abdominal pair and in *Hapalemur* the former are placed far out on the shoulder, below the acromion. For the Anthropoidea a single pectoral pair is characteristic.

Tail. In the majority of species the tail is long, or very long, and in one Family, the *Cebidae*, an American group, it is often prehensile, and aids the animal greatly in climbing, being easily able to sustain the weight of the body. In the most specialized cases the ventral surface of the tail, along the region where it comes in contact with the branches, is bare, and covered with friction ridges similar to those upon the palms and soles.[2] In some species the tail is reduced or wanting, and in the simians (including Man) this tailless condition is a characteristic of the Family. This condition is correlated with the assumption of an erect or semi-erect position, and the consequent necessity of strengthening the pelvic floor, which in this position becomes a point of weakness. To

[1] Whipple, I. L., The Ventral Surface of the Mammalian Chiridium, with especial reference to the condition found in Man. Zeitsch. fur Morphol. u. Anthrop. 1904. pp. 261–368.

Schlaginhaufen, O., Das Hautlistensystem der Primatenplanta. Morph. Jahrb. Bd. 33. 1905. pp. 577–671, and Bd. 34. 1905. pp. 1–125.

[2] Kidd, W., The sense of touch in Mammals and Birds. A. & C. Black, London. 1907.

Hepburn, D., The papillary ridges on the hands and feet of Monkeys and Man. Sci. Trans. Roy. Soc. Dublin, April. 1895. pp. 525–537.

reinforce this, certain of the tail muscles are diverted from their primary function and form the so-called "*diaphragma pelvis.*" This muscular structure reinforces the original membranes in that place, but necessitates the reduction of the part which it primarily supplied.

Skeletal peculiarities. Aside from certain skull peculiarities already mentioned a few other skeletal characters are of importance. It may be said in general that the skeleton as a whole is a primitive one, with the original elements characteristic of the Class present, well-developed and distinct, and with no marked modification anywhere, except perhaps in the skull, where the large size and heavy weight of the brain and the eyes necessitates some expansion and strengthening of parts. Here, aside from the completion of the orbit, already referred to, the frontals, parietals, and supra-occipital become more extensive, and the two frontals usually fuse along the median line, evidently a provision to increase the supporting power of these parts. Corresponding to the reduction of the nasal fossae the nasal bones are small, or even rudimentary, and in some cases the two become fused into a minute triangular scale, of no apparent functional value. In the Anthropoidea the two halves of the mandible become also fused into a single piece, in the others, they are distinct or semi-distinct.

The clavicle is always present and well developed. The radius is large and distinct, and has the power of turning about the ulna (pronation and supination). The carpus is primitive and the typical elements are nearly all distinct and separate. Thus the scaphoid and lunare are always separate, and the centrale is nearly always so. In the Anthropoidea it is present in all except the gorilla, the chimpanzee, and Man, in which it is fused with the scaphoid. The hand has typically five digits, but in a few cases the thumb is reduced. In the foot the tibia and fibula are distinct and well developed with the single exception of *Tarsius*, in which the distal half of the fibula is fused with the tibia. The tarsus is fairly typical, although in several of the lower forms, especially in *Tarsius*, it becomes involved in the formation of a lengthened foot through a prolongation of calcaneus, or calcaneus and naviculare. These Primates differ in this respect from all other mammals with a lengthening of the foot, for in other cases the elongation is produced by a lengthening of the metatarsals, and not of the tarsals.

7. The Three Sub-orders of Primates. The living members of this Order, grouped in accordance with their structure, may be arranged in three separate groups or Sub-Orders, as follows:—

Sub-Order 1. Chiromyoidea.

This group is represented by only one living form, the "aye-aye" (*Chiromys* or *Daubentonia*) of Madagascar. This is a small arboreal animal, with an appearance quite like that of a squirrel, although it is in reality more nearly related to the lemurs. The dentition is greatly modified and has the formula i $\frac{1}{1}$, c $\frac{1}{0}$, pm $\frac{1}{0}$, m $\frac{3}{3}$. The single pair of incisors in each jaw are very large and chisel-like, thus increasing the general resemblance to a rodent. The hands and feet possess each five digits, and betray their primate affinities by the presence of a typical nail on the first digit of the hind-feet, although the remaining digits are all clawed. The digits of the hand are extremely long and slender, and in this respect the middle digit far surpasses the others, forming a thin, jointed probe, used by the animal in secreting its food in the crevices of bark and in extricating it from the same. In the skull the margin of the orbit is complete, but the two lateral halves of the mandible are distinct. Judging from living forms alone Chiromys is a singularly isolated animal, with no near affinities, and is only to be accepted among the Primates as a much modified and specialized form. Many zoölogists place it among the lemurs, giving it a Family rank, rather than that of a Sub-Order. Others, however, taking into consideration the remains of extinct forms, have placed with this animal certain fossil forms (*Microsyops, Mixodectes*), themselves not easy to classify, and from these form the Sub-Order Chiromyoidea, as given here.[1]

Sub-Order 2. Lemuroidea.

These are the semi-apes, or lemurs, a fairly large group of tropical Eastern Hemisphere forms. A number of species, like the slow loris (*Nycticebus*) and the slender loris (*Loris*), are found in

[1] Cf. Wortman, J. I., Studies of Eocene Mammalia; in Amer. Journ. Sci. Vol. XVI, 1903. pp. 345–368.

India and the adjacent countries; a few like the potto (*Perodicticus*), the maki (*Arctocebus*), and the galagoes, occur in Africa; but the majority of the species are confined to the great island-continent of Madagascar and its associated islands. This singular distribution over such widely separated areas, especially the marked concentration of the group upon the island of Madagascar, suggests the former presence of a continuous land area, connecting Africa, and India, upon which the lemurs may have originated. The later subsidence beneath the sea of the land connection between Africa and India, leaving as fragments Madagascar, Mauritius, and Comoros, and other adjacent islands, must then be assumed, an assumption suggested by many facts of animal and plant distribution aside from the lemurs. Since, however, these latter animals are the most characteristic forms of these continental remains, Prof. Haeckel has suggested the name "Lemuria" for the hypothetical continent, but it is to be remembered that we have no other record of such a land than the distribution of the Flora and Fauna.

Sub-Order 3. Anthropoidea.

This group includes the monkeys, apes, and Man, and differs from the two previous Sub-Orders by a number of definite structural peculiarities. It is, like the two others, primarily a tropical group, and possesses a large number of representatives in both Hemispheres, although those of the Old and the New World are anatomically quite distinct. The words "monkey" and "ape," as used in literature, seem to be employed quite indiscriminately, but it is convenient in scientific writing to designate the smaller tailed species, as monkeys, and the larger man-like ones, without tails, as apes. This distinction was made by the seventeenth century naturalist John Ray, and still has some literary sanction.[1]

[1] In applying English names to these and other Primates one is confronted at the outset by the usual confusion of terms which always results from the constant misapplication on the part of an indifferent and careless public. We have, it is true, three good and simple words, *ape*, *monkey*, and *baboon*, which could be made of much service to us if each were restricted in meaning to a single group, and would serve to designate respectively (1) the large tailless forms, mainly of the family Hominidae, (2) the tailed forms belonging to the Lasiopygidae and Cebidae, and (3) a small group included within the Lasiopygidae, the genera *Cynocephalus*, *Papio*, etc., in which the snout is prolonged

Such will be the usage of this book, although in all cases where the meaning is not perfectly clear, or where accuracy is demanded, the scientific name will be employed.

Rejecting the aye-aye (*Chiromys*), the only living representative of the first Sub-Order, as too remote in structure for further consideration here, although full of suggestions to the investigator in its relation to the origin of the Primates, there remain the two large and important groups of the lemurs and the anthropoids, the differences between which may be next considered.

8. LEMUROIDEA VS. ANTHROPOIDEA. These two divisions of the Primates are in many ways so distinct that in the opinion of some specialists they should be raised to the rank of separate Orders. Their main structural differences may be placed before the reader in tabular form, as follows:—

LEMUROIDEA	ANTHROPOIDEA
Post-orbital partition of skull incomplete, although the orbital rim is entire. The orbital and temporal fossae are therefore confluent.	Post-orbital partition of skull complete, with the exception of the inferior orbital fissure, thus separating the orbital and temporal fossae.
Lacrimal foramen external to the orbital rim; that is, facial in position.	Lacrimal foramen internal to the orbital rim, that is, included within the orbit. (External in *Tarsius*.)

into a muzzle. This use seems, indeed, in spite of much indecision and confusion of the subject, to have been the original one, and generally understood during the Seventeenth century, since we find the following passage in the writings of John Ray, under the date of 1693. He says "*Simiae* dividuntur in cauda carentes quae *Simiae* simpliciter dicuntur, et caudatas quae *Cercopitheci* appellantur. Quae prioris generis sunt Anglice *apes* dicuntur; quae posterioris *monkeys*. In his quae rostro sunt productiore caninum referente *Cynocephali* appellantur. Atque vel caudis longis sunt, vel caudis brevibus *Papiones* dicti, Anglice *Baboons* magnitudine etiam insignos."

In this book, wherever the English terms are employed, this clearly defined usage of Ray will be followed, i. e., the word *apes* will refer to the lower members of the Hominidae, *monkeys* to the majority of the Lasiopygidae, the Cebidae and the Callithricidae, and *baboons* to those genera of the Lasiopygidae that possess a long dog-like snout (*Cynocephalus, Papio, Theropithecus*, etc.).

LEMUROIDEA	ANTHROPOIDEA
Digit II of the hind foot provided with a claw; all the rest bear nails.	In the marmosets (*Callithricidae*) digit I of the hind foot bears a nail, the others, claws. In *Tarsius* digits II and III of the hind foot bear a claw, the others, nails. In all the rest all the digits bear nails, never claws.
Mammary glands restricted in number; most commonly a single pair, pectoral in position, or two pairs, one pectoral and one inguinal. *Loris* and *Galago* may have two pectoral pairs.	In *Tarsius* one pectoral pair, almost axillary in position, and one abdominal pair. In all the rest a single pair, pectoral in position.
Dental formulae:— Typical, $\frac{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}=36$ Family Indrisinae, $\frac{3\text{-}2\text{-}1\text{-}2\ \ 2\text{-}1\text{-}2\text{-}3}{3\text{-}2\text{-}0\text{-}2\ \ 2\text{-}0\text{-}2\text{-}3}=30$	Dental formulae:— Cebidae, $\frac{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}=36$ Tarsius, $\frac{3\text{-}3\text{-}1\text{-}2\ \ 3\text{-}1\text{-}3\text{-}3}{3\text{-}3\text{-}1\text{-}1\ \ 1\text{-}1\text{-}3\text{-}3}=34$ Callithricidae, $\frac{2\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}2}{2\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}2}=32$ Lasiopygidae, $\frac{3\text{-}2\text{-}1\text{-}2\ \ 2\text{-}1\text{-}2\text{-}3}{3\text{-}2\text{-}1\text{-}2\ \ 2\text{-}1\text{-}2\text{-}3}=32$ Hominidae, The same as in Lasiopygidae.

Of these characteristics the first is perhaps the most fundamental and should constitute one of the first anatomical features learned by the amateur. It is illustrated in Figs. 1-3, which show three skulls, one a carnivore, one a lemur, and one an anthropoid. In the first (*Mustela*) the orbital and temporal fossae are widely confluent, although the suggestion of a separating bar is seen in the processes extending towards each other from the jugal and frontal bones. In the second case (*Lemur*) the processes have met,

forming a bar which completes the rim of the orbit, and partially separates it from the temporal fossa, although underneath the bar the two cavities are still in free communi-

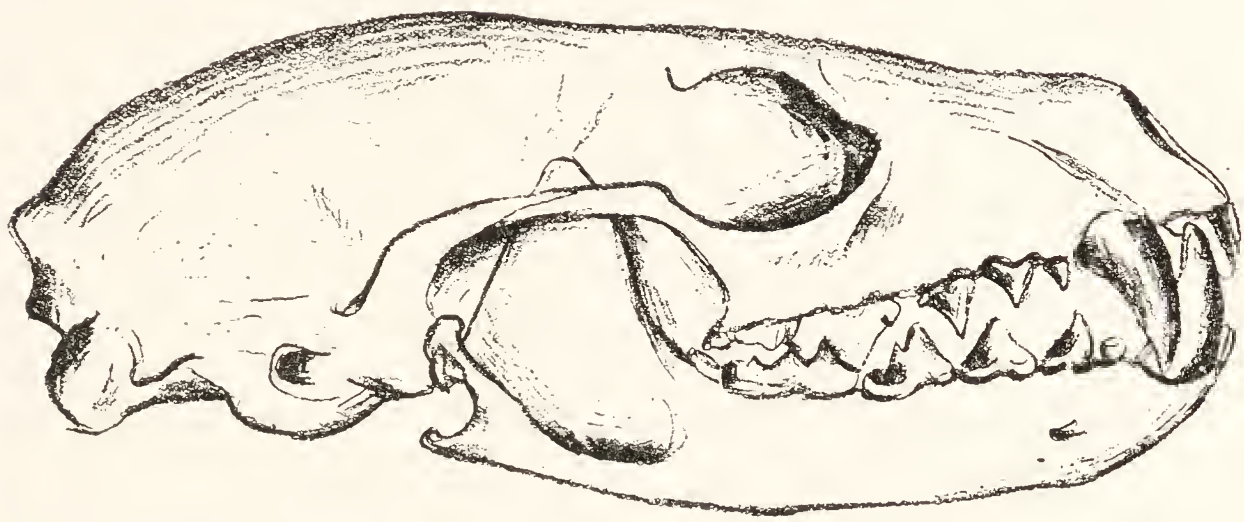

Fig. 1. Skull of *Mustela martes* (Marten), showing temporal and orbital fossae widely confluent, as in the majority of mammals.

cation. In the third case (*Hylobates*) a thin partition has developed from the inner side of the bar, mainly from the jugal, and has joined a similar process from the alisphenoid,

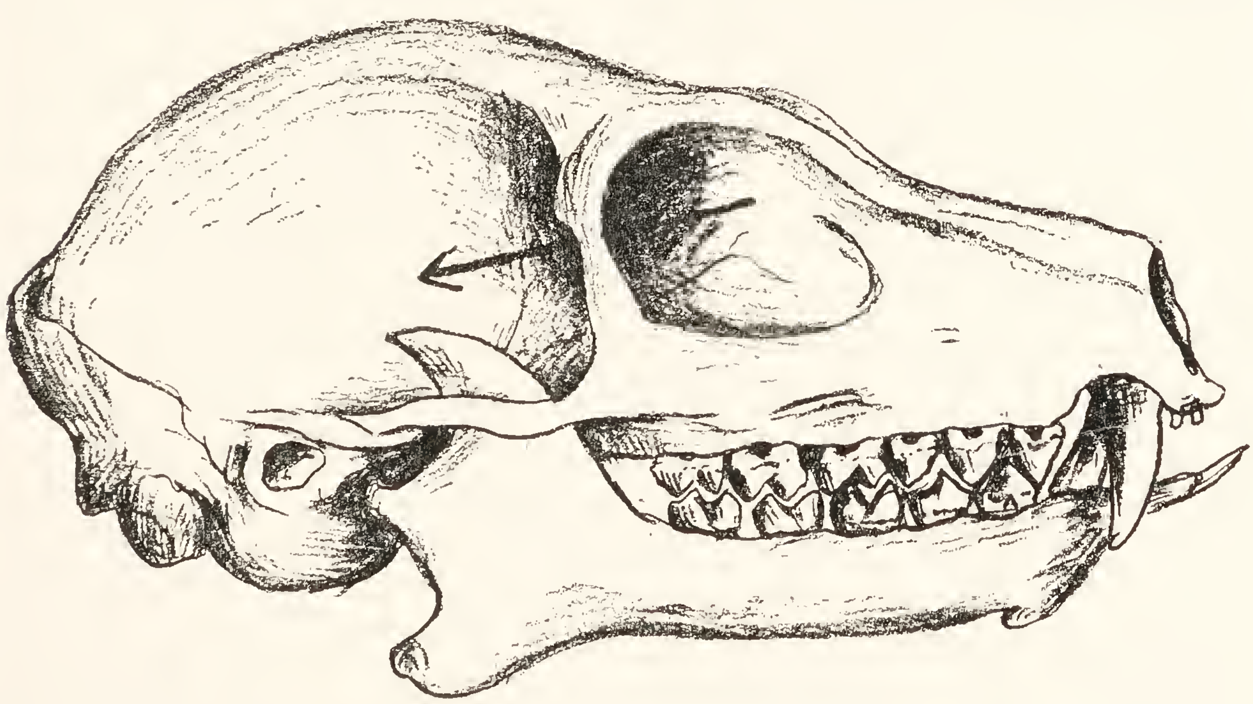

Fig. 2. Skull of *Lemur catta*, showing temporal and orbital fossae communicating, though separated externally.

completely separating the two fossae in question except for a narrow fissure, the inferior orbital.

A possible reason for this development, which is so characteristic of the anthropoids, may be found in the hypothesis,

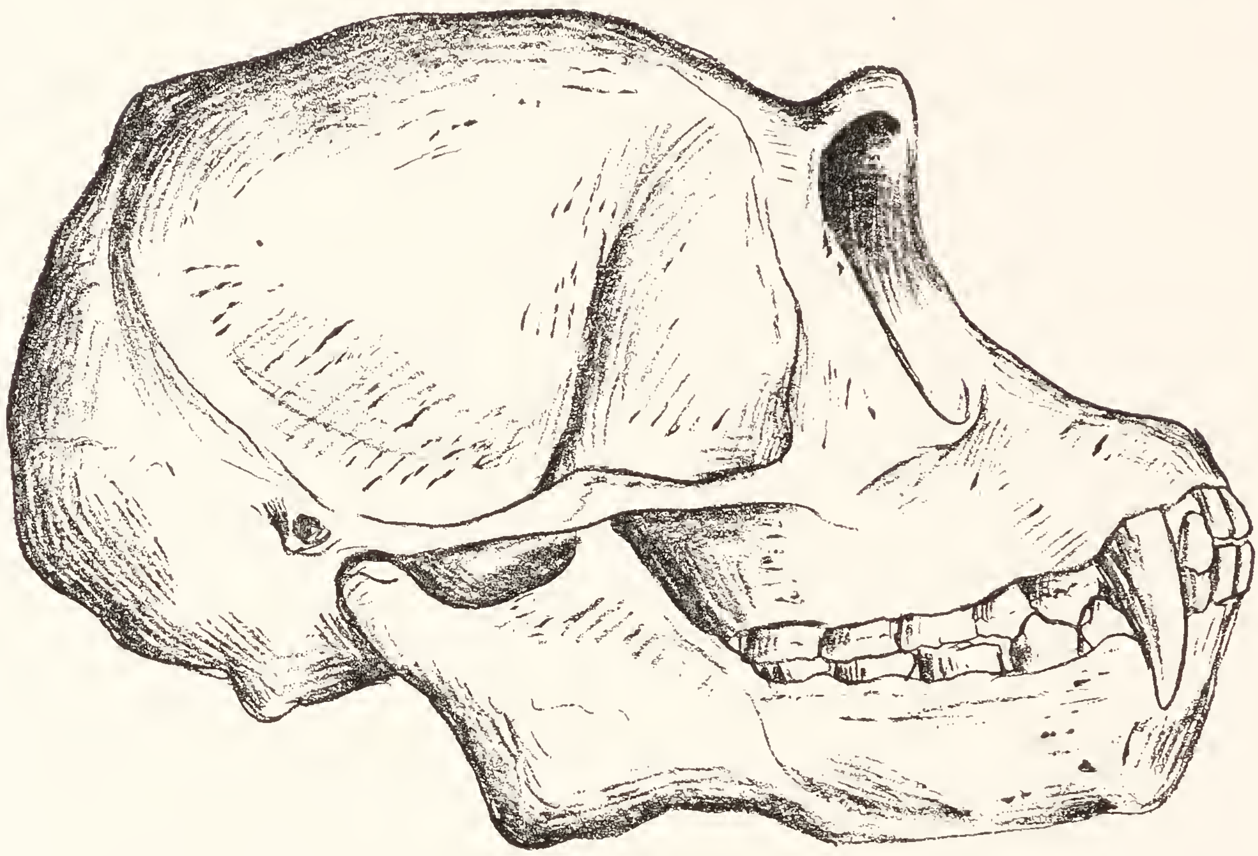

FIG. 3. Skull of *Hylobates leuciscus*, an anthropoid, showing a complete partition separating the temporal and orbital fossae.

suggested also in other ways, that the early forms were nocturnal, as is still the habit of the lemurs; that the nocturnal habit necessitated the development of large eyes; and that the completion of the orbit became necessary in order to strengthen the supporting parts. As these early anthropoids were small forms, like *Tarsius*, the eyes became proportionately so large, that they encroached on the nasal cavities, and reduced the sense of smell, while the huge cup-shaped orbits, forming bony eye capsules, projected from the rest of the face, especially above and laterally, and produced the pronounced superciliary ridges and lateral wings, so characteristic of many of the present day anthropoids (e. g., the gibbons). None of the other characters given are as positive in the way of diagnosis as this first one. Thus, in the matter of the *distribution of claws and nails*, while the possession of a single claw on each hind foot is a constant peculiarity of the lemurs, and in a general way may be considered to mark a lower stage of development than one in which all the claws have been converted into

flat nails, yet in *Tarsius*, in which the orbital and temporal fossae are completely separated as in the higher Primates, two digits of the hind feet, II and III, possess claws, and in the marmosets (Callithricidae), in other respects true anthropoids, all the digits are clawed with the exception of the first digit of the hind foot. The *distribution of mammary glands*, is, perhaps, a little more definite, for if we except *Tarsius*, the lowest member of the group, all the Anthropoidea alike possess a single pair, pectoral in position, yet it must be remembered that there are true lemurs with the same peculiarity, although in these animals as a rule there are also either an abdominal or an inguinal pair, or else there are two pairs of pectoral ones. Of the several *dental formulae* a number of them are special modifications, appearing in only a few species, and derived from the more typical forms by a slight change. We have some reason to believe that the dental formula of the common ancestor of the modern Primates, both lemurs and anthropoids, was $\frac{3\text{-}4\text{-}1\text{-}2\ 2\text{-}1\text{-}4\text{-}3}{3\text{-}4\text{-}1\text{-}2\ 2\text{-}1\text{-}4\text{-}3}$; that is, there were, in each jaw-half, two incisors, one canine, four premolars, and three molars. From this condition the typical formula for the lemurs is derived by the reduction of one premolar, the first. This same result is shown in the Cebidae, among the anthropoids, and from this *Tarsius* differs in only one respect, the loss of one of the lower incisors. The anthropoids of the Old World, including Man, a group the members of which are in other respects also closely related to each other, have suffered one more reduction from the original number, the loss of the second also of the original four premolars. The other formulae met with are, like that of *Tarsius*, special modifications affecting rather specialized groups.

Finally, the character which concerns the *position of the lacrimal* foramen is of far less weight than has been supposed, and cases must be recognized among the lemurs in which the foramen is quite within the orbit, while in *Tarsius*, counted

here as an anthropoid, but with many lemurine characteristics, the foramen is outside of the orbit, as in the typical lemurs. From the study of extinct lemurs, moreover, in which the condition is as in the Anthropoidea, within the orbit, and from other indications, it may be concluded that the extra-orbital position of the foramen is a recent specialization.

Q SYNOPSIS OF LIVING LEMUROIDEA. The Lemuroidea as limited in this work, that is, freed from *Daubentonia* (*Chiromys*), the aye-aye, which is too unlike the typical lemurs to be united with them, and also freed from *Tarsius*, which is probably not a lemur but an anthropoid, is a fairly homogeneous group, the primary sub-divisions of which have about the value of Sub-Families. Elliot includes them all, lightened as above, within the single Family of Nycticebidae, but adds to this also the two other Families of Daubentoniidae and Tarsiidae, here otherwise disposed of. Of these, one Sub-Family, the Galaginae, is wholly African; another, the Lorisinae, is in part African, and in part Asiatic (India, E. Indies, Siam, etc.) but all the rest are confined to the great island-continent of Madagascar, and its adjacent islands. The detailed synopsis follows.[1]

[1] The synopses given in this book are in accordance with the rather new work by Daniel Girard Elliot, "A Review of the Primates," 3 Vols., published by the American Museum of Natural History, 1913. Like all modern systematic work on Zoölogy or Botany, it follows the law of priority, and necessarily replaces well-known names by others, some of which are unfamiliar, while others have long been used erroneously to designate other forms than those to which they were originally applied. Thus the long-used *Cercopithecus* for the name of an Asiatic Genus, seems to have first been used for a Genus of American marmosets, and thus the Asiatic Genus has no right to the title. This must therefore be dropped, and with it goes the name of the Family "Cercopithecidae" to designate the monkeys of the Eastern Hemisphere. This must now be replaced by Lasiopygidae, from the Genus *Lasiopyga*, which is practically equivalent to the old Genus *Cercopithecus*. As *Simia* was first used to designate the "Barbary Ape" it cannot be used for the orang-utan, as formerly, and there falls with it the Simiidae thus far quite universal among anatomists and anthropologists to designate the great Man-like apes. As the word *Pongo* must be used instead of *Simia*, Pongiidae must replace Simiidae. Similarly the old-time Hapalidae (the marmosets) is now the Callithricidae,

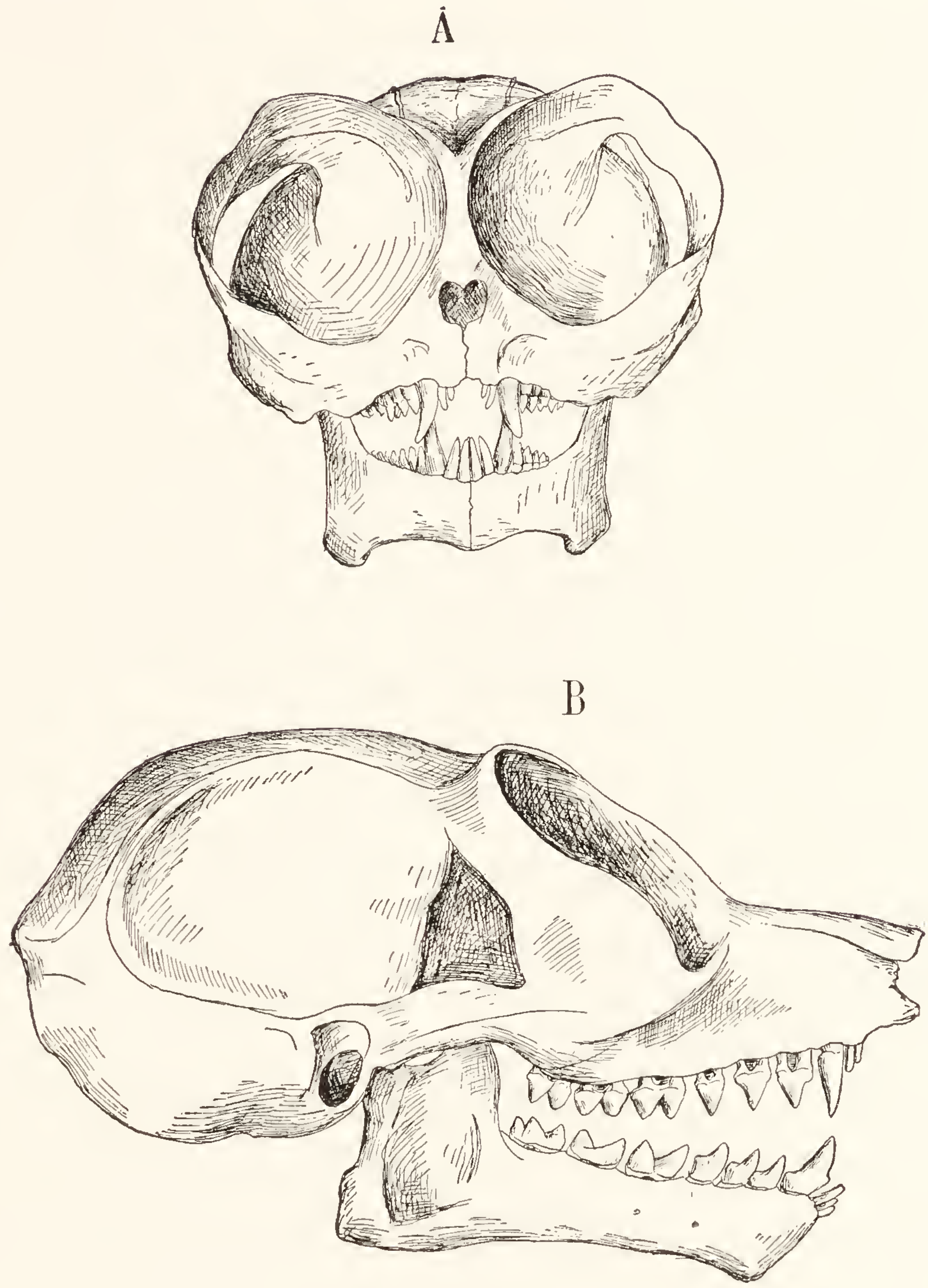

FIG. 4. Skull of *Loris gracilis*, the "agile lemur." Habitat: Ceylon and Southern India. Dental formula, i $\frac{2}{2}$, c $\frac{1}{1}$, pm $\frac{3}{3}$, m $\frac{3}{3}$. A. Front view; B. Side view. 4/3 natural size.

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and so on. It is likely that these new terms will become generally adopted, as has already been done by G. S. Miller, in his "List of North American recent Mammals," Bulletin 128 of the U. S. National Museum, but, unfortunately for us in the present argument, as this list is confined to North America, there is little opportunity for mentioning many Primates. He does, however, enumerate some 27 Species and Sub-species, including several introduced species, like *Lasiopyga callitrichus* and *Lasiopyga mona*, and, more surprisingly, *Homo sapiens*, of which he says "Range now almost universal." Elliot, although his work embraces three large volumes, does not even mention this "almost universal" species!

Nycticebidae	
Lorisinae	
Loris (slender loris)	2 sp. India
Nycticebus (slow loris)	10 sp. E. Indies, Siam, Anam, etc.
Arctocebus	2 sp. Africa
Perodicticus	5 sp. Africa
Galaginae (bush babies)	
Galago	21 sp. Africa
Hemigalago	3 sp. Africa
Lemurinae. All Madagascar	
Chirogale (mouse lemurs)	5 sp.
Microcebus (dwarf lemurs)	4 sp.
Mixocebus (the hattock)	1 sp.
Altililemur (fat-tailed lemurs)	2 sp.
Lepidolemur (sportive lemurs)	7 sp.
Myoxicebus (gentle lemurs)	3 sp.
Lemur (true lemurs)	14 sp.
Indrisinae. All Madagascar	
Lichanotus (the avahi)	1 sp.
Propithecus (sifakas)	2 sp.
Indris (black indris)	1 sp.

10. The Subdivisions of the Anthropoidea. The large and varied group of animals which, in accordance with the foregoing definition, are included under the head of Anthropoidea, must be again subdivided into three distinct though very unequal groups to emphasize their structural differences. The first of these groups contains but a single living species, although several extinct forms are known which are evidently related to it; the second contains a single Family, all American; and the third, the most numerous, group contains, as usually considered, four Families, arranged here as three, and representing both Hemispheres. These groups are as follows:—

Group 1. Paleopithecini.

Family: *Tarsiidae.* (One living Genus, *Tarsius;* from Borneo, Celebes and the Philippines.)

Group 2. ARCTOPITHECINI.

Family: *Callithricidae.* (The "marmosets"; Central and South America.)

Group 3. NEOPITHECINI.

Family 1. *Cebidae.* (American monkeys; Central and South America.)

Family 2. *Lasiopygidae.* (Old World monkeys; tropics of the Eastern Hemisphere.)

Family 3. *Hominidae.* (Anthropoid apes, Man; tropics of the Eastern Hemisphere. One Genus, *Homo*, has become universally distributed.)

The following are the main characteristics of the three groups:—

Group 1. PALEOPITHECINI. There is but one living Genus to represent this group, but numerous extinct forms are known which are closely related to the recent form and thus give to the group a number of representatives (cf. Chapter II). While, however, there is a complete agreement concerning the close relationship of the members of this group among themselves, opinions are considerably divided as to the place of the group as a whole; some investigators placing it among the lemurs, near the Sub-Family of the Lorisinae; while others, as is done here, place the group among the anthropoids, but give it the value of an separate subdivision, below the other and more typical representatives of the Sub-Order.

Tarsius, the sole living Genus, is represented by several closely allied species (*T. spectrum; T. fuscus*), found in the more western of the East Indies and in the Philippines. *Tarsius* is a small arboreal form of singular appearance and nocturnal habits, with enormous round eyes, a short snout, and a thin, nearly naked, tail, with a tufted tip. Its feet are quite monkey-like, especially in the flat nails, which occur on all of the digits except the second and third of the hind feet; the first digit of the foot is opposable but that of the hand is not. Two proximal bones of the tarsus (calcaneus and naviculare) are much elongated, and give the

leg an extra joint, a peculiarity which gives the animal the power of making prodigious leaps with the hind legs, the fore legs being passive. From this lengthened tarsus the animal derives its name.

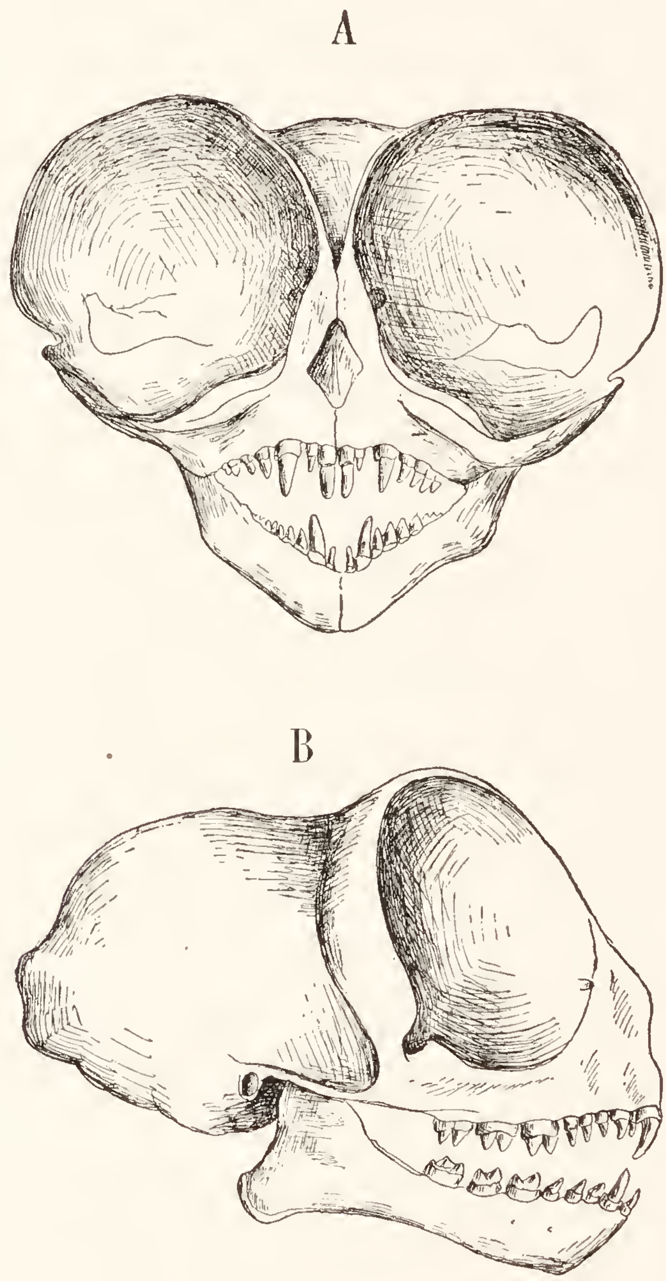

Fig. 5. Skull of *Tarsius spectrum*, the "spectral Tarsier" or "Kobold Maki" Habitat: Java, Sumatra, Borneo, and adjacent islands. An allied species inhabits the Philippines. Dental formula: i $\frac{2}{1}$, c $\frac{1}{1}$, pm $\frac{3}{3}$, m $\frac{3}{3}$. A. Front view (norma frontalis); B. Side view (norma lateralis).

The skull exhibits certain definite Anthropoid characteristics; a forward position of the foramen magnum and the occipital condyles, the passage of the internal carotid artery through the petrous bone, and the complete partition

between the orbit and the temporal fossa. The dentition, $\frac{3\text{-}3\text{-}1\text{-}2\ 2\text{-}1\text{-}3\text{-}3}{3\text{-}3\text{-}1\text{-}1\ 1\text{-}1\text{-}3\text{-}3}=34$, is peculiar in the loss of one of the lower incisor teeth, but is otherwise like the typical lemurs and the American monkeys (Cebidae).

Group 2. Arctopithecini. This group includes a single rather large Family of small Central and South American animals known as "marmosets" (*Callithrix*) and "tamarins" (*Leontocebus*), popularly classed with the true monkeys, although possessed of certain evident characteristics which

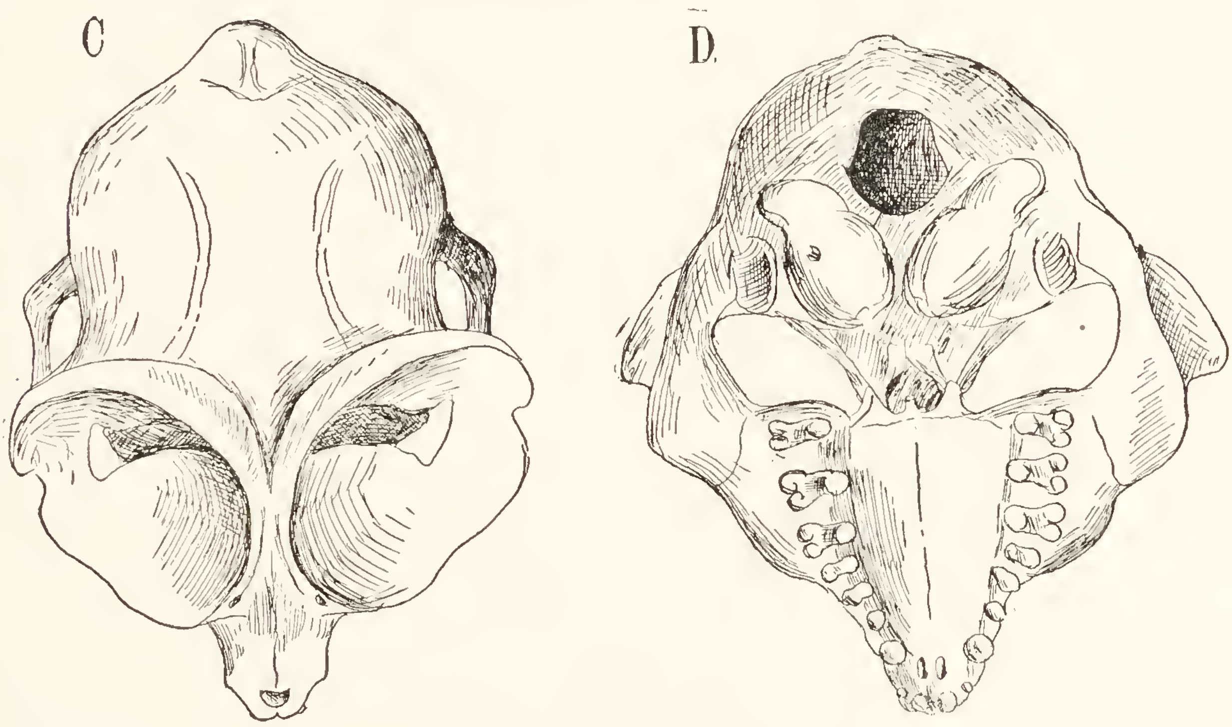

Fig. 5 (cont.). C. From above (norma verticalis); D. From beneath (norma basilaris). All figures 4/3 natural size.

are distinctive. Of these the most obvious lies in the structure of their fore and hind feet, the digits of which are equipped throughout with claws, with the exception of the first digit of the hind foot, which bears a typical anthropoid nail. This digit is also opposable, but the corresponding one of the fore foot is not. The dental formula, $\frac{2\text{-}3\text{-}1\text{-}2\ 2\text{-}1\text{-}3\text{-}2}{2\text{-}3\text{-}1\text{-}2\ 2\text{-}1\text{-}3\text{-}2} = 32$ possesses one unique character, namely, the loss of one molar on each side of each jaw; otherwise the formula is like that of the majority of the lemurs and the American monkeys (Cebidae). In the completeness of

the partition between the orbit and the temporal fossa, in the position of the foramen magnum, and in that of the foramen for the internal carotid artery, this group is definitely anthropoid and suggests in general a stage beyond *Tarsius*, although the clawed digits are a low character, and their presence here is something of a puzzle. On the whole it may be safe to consider this group as an early specialization from the main stem of the anthropoids, for the details of which we await the discovery of the fossil record, a line of investigation which has thus far yielded no clew in this direction.

Group 3. Neopithecini. This is by far the largest of the three anthropoid groups, counting living species alone, and consists of the typical monkeys and apes, the ascendant anthropoids of the present day. In them the fundamental anthropoid characters, as enumerated above, come to their most complete expression, and of these the most obvious character is the complete equipment of the digits with flat nails, every original claw having finally succeeded in effecting its transformation. Within the group, however, there are differences in dental formulae; in the degree of opposability of the first digit of both fore and hind feet, the shape and proportions of the nasal septum, and so on, by means of which the group may be divided into Families, although the number and extent of these divisions is still in some particulars a matter of discussion. Especially is this true with regard to Man and his nearest allies, where the natural human *amour propre*, and the traditional idea that Man is in some way distinct from other animals, has led us to magnify the importance of slight differences of structure. Throughout the rest of the animal kingdom a Family is treated as an important group, the distinctive characteristics of which must be considerable and quite fundamental; among other mammals there is usually at least a difference of dental formulae between allied Families, and in many cases there are several different formulae within the limits of a single Family; but in the case of the higher anthropoids

the separation of Families is founded upon so superficial a character as the presence or absence of a tail, of callosities over the ischiadic bones, or even the opposability of a digit. Thus, of the four Families into which the Neopithecini are usually divided, the Cebidae, distinguished by a wide nasal septum, and often a prehensile tail, form a fairly natural group, while the remainder, all with a narrow nasal septum and without a prehensile tail, are not sufficiently distinct to separate into Families in accordance with the standard that obtains elsewhere among the mammals; and the attempt to set apart the Genus *Homo* from the rest of the Hominidae as a distinct Family, mainly on the basis of a non-opposable great toe (see below), would be laughable if it were not for some people so vital a matter. Transfer the field of discussion to the rodents, or to any equally remote group, and no one would think of separating Families on such slight differences.

However, in compliance with the common usage, we have thought best to admit here the division of the Old World group, the "Catarrhini" of many authors, into the two Families of Lasiopygidae and Hominidae, on the strength of such minor differences as the presence or absence of ischial callosities, a difference in the sternum, and so on, inadequate as they seem for the basis of such separation, but cannot follow custom in the further separation of the Genus *Homo* from the Pongiidae (Simiidae) as an independent Family. *Hylobates* and *Homo* are anatomically about equally distinct from the rest of the Family, and these differences may be well expressed by the separation of the Family into three Sub-Families, as given below.

11. Synopsis of the Living Anthropoidea.[1]

Sub-Order: ANTHROPOIDEA.

Group 1. Paleopithicini.

Family 1. *Tarsiidae* (spectral maki; kobold maki). [Seven similar species, from the Philippines, E. Indies, etc.]

[1] Based largely upon D. G. Elliot, loc. cit. Cf. note on p. 30.

Group 2. Arctopithecini.

Family 1. *Callithricidae* (marmosets, tamarins, etc.). [Wholly confined to the New World, i. e., Central and South America. These, with the Cebidae, form the old group of the "Platyrrhini."]

Group 3. Neopithecini.

Family 1. *Cebidae* (howlers, spider monkeys, capuchins, etc.). [This wholly New World Family constitutes, with the previous one, Callithricidae, the group of Platyrrhini, long used to divide the Anthropoidea into two parts. It is often convenient, but not sufficiently fundamental.]

Alouatta (howling monkeys)	Numerous species
Pithecia (sakis)	Numerous species
Cacajao (uakari monkeys)	3 species
Saimiri (squirrel monkeys)	Numerous species
Aotus (douroucoulis)	Many species
Ateleus (spider monkeys)	Numerous species
Brachyteleus (woolly spider monkey)	1 species
Lagothrix (woolly monkeys)	6 species
Cebus (capuchins)	Many species

Family 2. *Lasiopygidae*

[These include the lower monkeys of the Old World, such as the baboons, sacred monkeys, Guenons, and Macaques. It was formerly the equivalent of the Cercopithecidae.]

Sub-Family 1. *Lasiopyginae*

Papio (dog-faced baboons)	Numerous species, Africa
Theropithecus (geladas)	2 species, Abyssinia
Cynopithecus (black ape)	1 species, Celebes
Magus (Celebes macaques)	3 species, Celebes
Simia (Barbary ape)	1 species

[The name *Simia* seems to have been first definitely applied to the Barbary ape of Morocco and Algeria. It inhabited until recently the Rock of Gibraltar, and was thus the only ape indigenous in Europe. It has since been largely used to designate the orang-utan of Borneo, but if the name be restored

to its earlier use, the name must be discontinued as a name for the orang-utan, which must go back again to its earlier name of *Pongo*.]

Pithecus (macaques)	Many species
Cercocebus (mangabeys)	Many species, Africa
Rhinostigma (owl-faced guenon)	1 species, Africa
Lasiopyga (the guenons)	Many species, Africa

[This is the old Genus *Cercopithecus*, now used for a Genus of tamarins, American monkeys. It is divided into many Sub-Genera.]

Miopithecus	2 species, Africa
Erythrocebus	Several species, all African

Sub-Family 2. *Colobinae*

Pygathrix (langurs)	Many species, Asiatic

[These are all Asiatic, mostly the old Genus *Semnopithecus*.]

Rhinopithecus (retrousse-nosed langurs)	4 species, Asiatic
Simias (Pagi Is. langur)	1 species
Nasalis (proboscis monkey)	1 species, Borneo
Colobus (the guerezas)	Many species, Africa

[These have no thumbs, or possess them in a rudimentary state. All are African.]

Family 3. *Hominidae*

Sub-Family 1. *Hylobatinae*

Hylobates (gibbons)	12 species, Asiatic
Symphalangus (siamangs)	2 species, Sumatra

Sub-Family 2. *Pongiinae*

Pongo (orang-utans)	Probably 2 species, Borneo, Sumatra
Gorilla (gorillas)	Probably 5-6 closely related species from Tropical Africa
Pan (chimpanzees)	About 10 species from Tropical Africa

Sub-Family 3. *Homininae*
Homo (Man) — Originally from the warmer parts of the Eastern Hemisphere; now "almost universal."

As the classification employed is based upon the newest one of D. G. Elliot, which is itself strictly based upon the law of priority, it will be very likely to cause embarrassment to those brought up to the classification that has obtained hitherto. As an aid for such we give here the older classification of the true monkeys and apes, as based largely on H. O. Forbes, 1897, and omitting from them, as he does, the Genus *Tarsius*, which he places with the typical lemurs. To him, also, the Hominidae include only Man, and the Simiidae are the large anthropoid apes.

Sub-Order I. ANTHROPOIDEA.

Family 1. *Hapalidae*
Hapale (Illiger, 1811)
Midas (Geoff., 1812)

Family 2. *Cebidae*
Sub-Family 1. *Nyctipithecinae*
Nyctipithecus (Spix, 1828)
Chrysothrix (Kaup, 1835)
Callithrix (Geoff., 1812)
Sub-Family 2. *Pithecinae*
Brachyurus (Spix, 1823)
Pithecia (Geoff., 1812)
Sub-Family 3. *Mycetinae*
Alouatta (Lacépède, 1807)
=*Mycetes* (Illiger, 1811)
Sub-Family 4. *Cebinae*
Cebus (Erxleben, 1777)
Lagothrix (Geoff., 1812)
Brachyteles (Spix, 1823)
Ateles (Geoff., 1806)

Family 3. *Cercopithecidae*

Sub-Family 1. *Cercopithecinae*

Papio (Erxleben, 1777)

Theropithecus (Is. Geoff., 1841)

Cynopithecus (Is. Geoff., 1834)

Macacus (Lacépède, 1801)

Cercocebus (Geoff., 1812)

Cercopithecus (Erxleben, 1777)

Sub-Family 2. *Semnopithecinae*

Semnopithecus (F. Cuv., 1821)

Colobus (Illiger, 1811)

Nasalis (Geoff., 1812)

Family 4. *Simiidae*

Sub-Family 1. *Hylobatinae*

Hylobates (Illiger, 1811)

Sub-Family 2. *Simiinae*

Simia (Linnaeus, 1766)

Gorilla (Is. Geoff., 1852)

Anthropopithecus (DeBlainville, 1839)

Family 5. *Hominidae.* [A Family to include Man, and, until recently, nothing else. Still, it is very difficult to separate this Family from the Simiidae by any criteria that are made use of elsewhere among mammals.]

12. THE CEBIDAE. This Family includes the American monkeys (excepting the marmosets), a group that has evidently passed through its later development independently of the monkeys of the Old World, and thus possesses several distinctive anatomical features not developed by the other division. The following are the most important characteristics:—

1. The *dental formula* is like that of the lemurs,

$$\frac{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}{3\text{-}3\text{-}1\text{-}2\ \ 2\text{-}1\text{-}3\text{-}3}=36$$

and differs from that of the Old World monkeys in the number of premolars, three in each half-jaw. The primitive number of premolars for Eutherian mammals seems to have been four, and there is some reason for believing that the reduction has taken

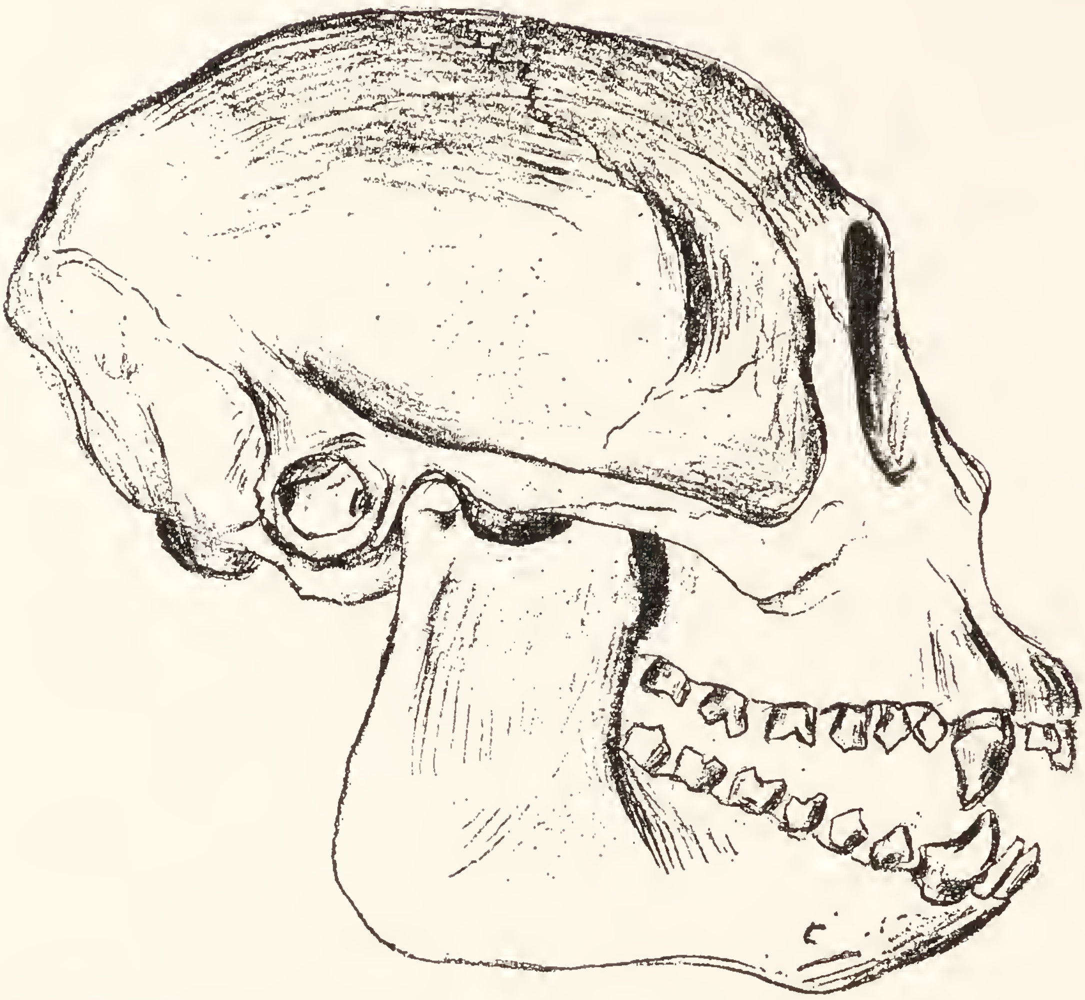

FIG. 6. Skull of *Alouatta villosa*, the "black Howler," one of the typical Cebidae. Note the three premolar teeth in each jaw, and the widely open auditory opening, unguarded by a bony canal.

place from before backwards, so that these animals as well as the lemurs have lost the first one, PM_1. This number of premolars, three, seems to be the original number for the Order of Primates, and in this respect the Cebidae are primitive, while the Old World forms have suffered a further modification in the loss of one more, the original PM_2.

2. An important character, seen only in the prepared skull, concerns the *external opening of the ear*. In all anthropoids, up to the time of birth, or in the advanced fetus, the *annulus tympanicus*, formed by the tympanic bone, forms a nearly complete ring about the ear opening, and frames in the outer drum head. In the Cebidae this earlier condition is permanent, and the tube leading from this point out to the exterior, the external auditory meatus, is formed wholly of cartilage; but in the Old World monkeys (the Families Lasiopygidae and Hominidae) an outgrowth of bone from this ring replaces the cartilage for a portion of its extent, and thus narrows the opening as seen in a prepared skull.

3. A very noticeable peculiarity, which differentiates at once the members of this Family from those of the Old World, is the *external nose, the nostrils of which are placed very far out on the sides, so that the septum between them is extremely broad.* This peculiarity, as it happens, is also shared by the marmosets (Callithricidae), and thus becomes a characteristic of all the anthropoids of the New World. Now, as the Old World monkeys, omitting *Tarsius,* which has until recently been classed with the lemurs, have the nostrils near together, with but a narrow septum between them, as in Man for example, this difference was formerly made the basis of a simple and very obvious classification, which divides the anthropoids into two groups, associated with the two Hemispheres, the *Platyrrhini,* or flat-nosed monkeys (the American forms), and the *Catarrhini,* or straight-nosed monkeys (the Old World or Eastern Hemisphere forms). Although this convenient grouping has the merit of being based upon a superficial character, and is thus easy of application in a given case, yet, through the recognition of *Tarsius* as a true anthropoid, through the isolated position and archaic characters of the Callithricidae, and the large amount of light thrown upon the subject by the discovery and study of numerous extinct forms, this classification becomes entirely obsolete, although the expressions "platyrrhine" and "catarrhine," as descriptive of anatomical conditions, and not used in a taxonomic, or classificatory, sense, are often convenient.

4. Here may be placed two characters of general interest, and of importance in a description of the Family, but as they are not inclusive and exclusive, that is, definite characteristics of all the members of the Family and not found elsewhere, they can not be made much use of for purposes of classification.

The first concerns the *tail,* which, in all American monkeys, with the exception of the Genus *Caçajao,* is large and of considerable length. In the Sub-Families Mycetinae and Cebinae it is prehensile and assists the animal in climbing. Such tails are also very stout and strong and can easily support the weight of the entire body, and in the typical cases, such as *Cebus,* the adaptation is so complete that the epidermis of the under side of the tail, where it comes in contact with external objects, has developed parallel ridges, like the friction skin of the palms and

soles, evidently for the same purpose, to increase the friction and prevent slipping. (Cf. § 6, *sub* "Hair.")

The second character is the condition of the *first digit*, both of the hand and the foot, the pollex (thumb) and the hallux (great toe). The hallux is always opposable, while, as a rule, the pollex is not, or only slightly so. It usually grasps a bough from the same side as do the other fingers, giving the entire hand the function of a hook rather than that of a pair of forceps or pliers. In some Genera, e. g., *Brachyteleus*, *Ateleus*, the pollex is more or less rudimentary, and may even show different degrees of this in the two hands of the same individual.

As a rule an opposable thumb and a prehensile tail do not occur in the same species, as one is a sort of compensation for the lack of the other. This circumstance, together with the fact that a prehensile tail occurs in this Family alone, should be borne well in mind, since in the popular estimation monkeys in general are supposed to possess both of these characters.

13. THE CERCOPITHECIDAE AND SIMIIDAE.[1] The Neopithecini of the Eastern Hemisphere, the "Old World monkeys" of earlier writers, form a natural group of closely related animals, the subdivision of which are hardly distinct enough to form more than the branches of a single Family. (Cf. § 10.) They are, however, commonly divided into the two Families of Cercopithecidae and Simiidae, from the latter of which Man is usually set apart by himself as the sole living representative of still a third Family, the Hominidae, a separation for which there is not sufficient anatomical warrant.[2] Still, the amount of structural difference necessary to establish Families, and whether such a difference

[1] The terms Cercopithecidae and Simiidae have long been used for the two Families of Old-World anthropoids. Elliot's nomenclature, which we are following in the main in this book, while introducing the name Lasiopygidae as an exact synonym for Cercopithecidae of the older classification, separates the forms which constitute the Simiidae of the older terminology into the Families Hylobatidae and Pongiidae. In the present work these latter Families, with the rank of Sub-Families, are united with a third Sub-Family, the Homininae, to constitute the Family Hominidae, which thus comprises, in addition to the Simiidae of the older terminology, the Genus *Homo*.

[2] Even Linnaeus, who upon theoretical grounds had every reason for

exists in this instance is mainly an academic question, and it is best here merely to set forth the differences and similarities that exist and assume in the matter of classification a middle ground between the conservative view that divides this group into three Families, and the somewhat radical one which wishes to treat it as two. In other words, the writer is unable to find a sufficient degree of structural difference between the Simiidae, as usually limited, and the Genus *Homo* to make a Family distinction between them, while he is willing to assume such a difference between the Cercopithecidae and the Simiidae, although he feels that even here, if the discussion concerned mammals less closely related to man, and did not involve the classifier himself, the two Families in question would be considered the two Sub-Families of a single Family, which would include all the Eastern Hemisphere NEOPITHECINI.

The principal features distinctive of the group as a whole (Cercopithecidae + Simiidae) are as follows:—

1. The *dental formula* is $\frac{3\text{-}2\text{-}1\text{-}2\ \ 2\text{-}1\text{-}2\text{-}3}{3\text{-}2\text{-}1\text{-}2\ \ 2\text{-}1\text{-}2\text{-}3}=32$, easily derived from the more primitive one of the Cebidae and the typical lemurs by assuming the reduction of one more premolar, in this case PM_2. This reduces the number of these teeth in each half-jaw from three to two, and the entire number of teeth from 36 to 32.

2. The *tympanic bone* does not remain in its primitive condition of a ring, annulus tympanicus, surrounding the outer drum head, as in the Cebidae, but sends out a bony outgrowth along the external auditory meatus, partly replacing the cartilage, and forming a longer or shorter bony tube, projecting outwards.

3. The *nostrils* are placed near together, and the septum between them, when viewed externally, is narrow. This feature is well shown in the human nose, but is equally well expressed in any of the smaller monkeys belonging to the group.

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separating Man from the apes, acknowledged the impossibility of finding structural differences to support this view. He says, "Mirum adeo parum differre stultissimam Simiam a sapientissimo Homine, ut iste geodaetes naturae etiamnum quaerendus, qui hos limitet."

4. The *tail*, usually long and well developed, is sometimes reduced and inconspicuous. When present it is never prehensile.

5. Both *pollex* and *hallux* are typically present and opposable. In *Colobus* the pollex is reduced, and in *Homo* the opposability of the hallux is lost.

Even after placing Man within the bounds of the Simiidae, the main differential characters of the two remaining subdivisions, the Cercopithecidae and the Simiidae, are not very fundamental as a whole, and in part relate to external features of superficial value, or mere differences of proportion. They are placed here in parallel columns for better comparison:—

CERCOPITHECIDAE (LASIOPYGIDAE)	SIMIIDAE (HYLOBATINAE AND PONGIINAE of the Author)
1. The tuberosities of the ischia are covered by bare areas of thick horny skin, usually of some conspicuous color. These are termed the "ischial callosities."	In the Sub-Family Hylobatinae ischial callosities are present but quite small. In all the rest they are entirely wanting.
2. The tail is usually present and well developed. It is occasionally reduced, and in extreme cases (e. g., the Barbary Ape, *Simia sylvanus* of Elliot; *Macacus inuus autt.*) is not visible externally.	The tail is always reduced; not visible externally.
3. Cheek pouches usually present (wanting in *Pygathrix*).	Cheek pouches always wanting.
4. In walking, the heel of the (hind) foot is raised from the ground (digitigrade); while sitting, however, the entire sole rests upon the ground.	In walking, the entire sole of the hind foot, from toes to heel, comes in contact with the ground, but shows a marked tendency to rest upon its outer edge. This latter is less marked in the Hylobatinae.

5. The sternum is narrow and is divided into several separate, rod-like pieces, as in most mammals.	The sternum is made up of separate pieces in very young animals; it develops later into a broad, flat bone, in which but three pieces may be distinguished.
6. The brain is moderately large; the roof of the cranium is arched upwards about as in the Cebidae.	The brain is large, or very large; the roof of the cranium is lifted upwards to a marked degree, giving the animal a definite forehead.

Of the above characters that of the flat sternum, together with the peculiarly shaped thorax which goes with it, a thorax in which the lateral width exceeds the thickness dorso-ventrally, seems to be the most definite in separating the Simiidae from the Cercopithecidae.

14. The Hominidae. Based upon structural characteristics, and following the usages of limiting Families among other mammals and divesting ourselves of the natural human prejudices, we have decided to unite into a single Family the great, tailless Apes of the Eastern Hemisphere, commonly called the Simiidae (Hylobatidae and Pongiidae of Elliot) and the Linnaean Genus *Homo*, into a single Family, the Hominidae. Aside from the anatomical characters of the forms now alive, the two groups of anthropoid apes and men are closely united by numerous extinct animals, to designate which as either "apes" or "men" has already caused much embarrassment, and the establishment of all under the bounds of a single Family is now an obvious step. The hypothetical scientist from the planet Mars, being brought alcoholic specimens from the Earth, would assuredly not hesitate to do so, and we, with the anatomical, embryological, and paleontological knowledge thus far obtained ought not to be far behind him.

At the present time, taking into consideration all the paleontological evidence thus far submitted, we are in position to establish three Sub-Families, two of which

have already been used extensively. These are the Hylobatinae and the Pongiinae. To these may be added the Homininae, long established as an independent Family, but without sufficient anatomical reasons.

If, now, we consider what we already know of extinct forms lying between modern man and the large apes, we can establish several hominid Genera, besides more than one species of *Homo*, and the entire Family will present about the following synopsis:—

Hominidae

Sub-Family 1. *Hylobatinae* (Gibbons)

Hylobates	12 species
Symphalangus	2 species

Sub-Family 2. *Pongiinae*

Pongo	Borneo, Sumatra

[If the Sumatran form be considered the same species as the one from Borneo, which is commonly the one studied, there is only a single species of this Genus. If they are different there are two.]

Pan (Chimpanzees)

P. chimpanse	Gambia, W. Africa
P. calvus	Gaboon; S. Cameroon
P. fuliginosus	French Congo
P. kooloo-kamba	Interior of Ogowé
P. schweinfurthi	Niam-niam country
P. aubreyi	Cameroon; Gaboon
P. vellerosus	Cameroon
P. fuscus	Gold Coast
P. leucoprymnus	Coast of Guinea

[This Genus needs revision, and at present we are not in condition to state the exact number of species and varieties. It is wholly an African Genus, and has about the same range as its near relative, the gorilla, but extends entirely across the continent, while the gorilla does not come so far East, but leaves off somewhere in the middle.]

Gorilla (Gorillas)

[There are apparently several species of the Genus. Elliot

enumerates two, with numerous varieties. He also mentions a similar one in the Genus *Pseudogorilla*.]

Pseudogorilla

P. mayema — Upper Congo

Sub-Family 3. *Homininae* (Men)

Homo

H. sapiens — Modern man, quite generally distributed over the earth; several more or less distinct varieties, but all considered to be of one species

The presence or absence of ischial callosities marks a definite distinction between the Hylobatinae and the following Sub-Family, the Pongiinae; but there is as yet no such definite character to separate this Sub-Family from the Homininae.

There are more definite differences between the Sub-Family Hylobatinae and the other two than there is at present between the Pongiinae and the Homininae, and the added data which may be obtained in the future may be expected to decrease rather than increase the differences here as elsewhere. Surely, "natura non facit saltum," and we may confidently predict a time when it will be generally acknowledged that Systematic Zoölogy exists only through the gaps caused by extinction.

Paleontological evidence in recent years has furnished a large number of species, some of which come within the Genus *Homo*, which so completely bridge over the gap which once existed between the two Sub-Families Pongiinae and Homininae, that it has become extremely difficult to keep the two as separate Sub-Families. An attempt to do this, later on, in Chapter III, while supplying much material for this work, will, at the same time, show the difficulties in the way, but will make no dogmatic attempt to effect a decision. As confined to living animals, the distinction between the three Sub-Families is plain, and the species *Homo sapiens* is as completely isolated from the rest of the Primates as could have been desired by the Seventeenth Century philosophers.

The anatomical differences between the Hylobatinae, and the two remaining Sub-Families of the Hominidae, are, in tabulated form, as follows:—

Hylobatinae	The Remaining Hominidae
1. The smallest in body of the group; of the several species the largest is about one meter high when standing erect, the others are about 70 cm.	All are considerably larger and heavier than Hylobates, although in some cases the total height of adult specimens may not much exceed that of a tall gibbon, owing to excessive shortening of the legs.
2. When walking erect they step upon the entire sole.	When walking erect they step more or less upon the outer edge of the foot ("Varus" position).
3. Possess small ischial callosities.	Ischial callosities entirely wanting.
4. Vertebral column without a lumbar curve.	Vertebral column with at least the suggestion of a lumbar curve; in some species this curve is a pronounced characteristic.
5. Ilia narrow and long, intermediate in shape between those of the Lasiopygidae and of the typical Pongiidae.	Ilia broad and short; the extreme in these particulars is shown by *Homo*.

Of the distinctive characters of the gibbons the small size and extreme length of arm are the most obvious, although a more careful scrutiny will reveal the ischial callosities small in area and nearly concealed beneath the heavy fur.

Geographically the gibbons are confined to the extensive forests of tropical South Eastern Asia and the adjacent islands, especially Borneo, Sumatra, and Java. On the mainland they inhabit Farther India and the peninsula of Malacca, thence follow the coast westward as far as Bengal.

In habit they are arboreal, and swing from bough to bough with great precision, avoiding obstacles. When on

the ground they walk erect, using the entire sole, and balance themselves with their arms, which are so long that they can rest the knuckles of their bent fingers on the ground

Fig. 7. The wau-wau gibbon, *Hylobates leuciscus*, Bornean race. Photographed from a stuffed specimen in the Smith College Collection; collected by William Howard Furness, Jr.

while standing erect or nearly so. Indeed they often progress by planting the knuckles firmly, stiffening the arms, and then swinging the legs and body through them after the manner of a man with a pair of crutches. Upon the

trees, however, there is no suggestion of the ungainly or the crippled, and one realizes that here the gibbon finds his natural habitat, to which he has become marvelously adapted. Here every gibbon becomes a gymnast, and "he

Fig. 8. Same as the foregoing; side view.

progresses by swinging himself end over end, holding by his hands while he gives his body a long swing toward another branch. His body becomes horizontal, he grasps the branch with his feet, and, letting go with his hands,

swings, head downward and backward, until he comes right side again, lets go with his feet and goes flying through the air to the next branch. He grasps with his hands, swings the other end of himself forward again, and so on. . . . By this revolutionary method he goes just as well as if he had a head on each end of his body. . . . A gibbon seems to progress entirely by the sole act of his will, and without taking the least thought as to the means."[1]

Their food consists largely of leaves and fruits, varied by insects and spiders, which they catch with their hands.

Several species have been established, which fall into two groups. The first group contains the single species *S. syndactylus*, the "si-amang." This is the largest of the Sub-Family, with a standing height of 1000 mm., approximately 40 inches. Its distinctive peculiarity is seen in the foot, in which digits II and III are fused as far as the distal end of the second phalanges, leaving the terminal joints free. The remaining species, *H. lar; H. leuciscus; H. agilis; H. hoolock;* etc., are scarcely more than color varieties of one species, and naturalists differ much in the number and limits of these species. They are all considerably smaller than *H. syndactylus,* averaging 700 mm. in height.

15. The Genus Pongo: the Orang-utan. There is but one species of this genus, found only in the two great islands of Borneo and Sumatra. In the latter it is scarce and seems to be dying out. It is much larger than any of the gibbons, being as heavy as a man, but with quite different proportions, since its legs are proportionately the shortest, and its arms the longest, of any of the Family.

The body appears to be fairly well clothed with coarse red hair, which in places, as upon the shoulders and arms, and over the back, hangs in long, matted locks, but over the chest and front of the abdomen, on the sides of the body, and upon the front sides of the legs, the hairs are often so

[1] Hornaday, Wm. T.; Two Years in the Jungles; Scribner's, New York, 1908. Chapters XXXV and XXXVI.

scanty as to leave the skin almost naked. Over these surfaces the skin is light in color, but that of the face, which is also for the most part bare, is a deep black. The face is extremely narrow across the temples, and the eyes are

FIG. 9. Living gibbon (*Hylobates*).
Photograph from the Zoölogical Park. Courtesy of the New York Zoölogical Society.

small and set very near together, but the snout and jaws are heavy and protruding, so much more so, in fact, than in any other of the Family, as to render this a distinctive feature. In adult males there often develops along each cheek a lateral fold of rough, firm skin, that adds much to the width of the face, and to the general brutishness of the expression. In these also there often develops upon the upper lip a fairly strong mustache of long, coarse hairs, especially heavy laterally, above and at the sides of the corners of the mouth. The ears are especially small, and are nearly concealed by the hair.

The orang is the most perfectly arboreal of any of the Pongiidae and is ill at ease on the ground. It inhabits forests

[1] A detailed account of the Orang-utan in its native habitat is found in that

Fig. 10. Orang-utan or "Mias"; *Pongo pygmaeus* (*Simia satyrus*).

Front view of male, of the variety known locally as "Mias pappan," and characterized by the two prominent lateral folds of skin on the cheeks, that have the effect of broadening the face and making it look more formidable. From a stuffed specimen in the Smith College Collection; collected in Borneo by William Howard Furness, Jr.

classic of naturalists' experiences, the "Malay Archipelago" by Alfred Russell Wallace, Chapter IV. Here the beast figures under the name "mias," which is a word in the language of the Dyaks, the aboriginal natives of the interior

which abound in large limbs, horizontally placed, and its usual mode of progression is by walking along these, at the same time grasping the smaller twigs and branches overhead for the purpose of steadying itself. Only when at the end of the limb does it use its arms to swing by, after the manner of the gibbon, and even then never seems to grasp the larger boughs singly, but gathers up a handful of the smaller twigs into one of the abnormally long hands and swings by these to an adjacent tree, to a second long, horizontal limb when possible, and so on. As each individual lives in a definite locality, and confines himself to a range of but a few miles under ordinary circumstances, it evidently comes to learn the topography of the individual trees, whose limbs serve it as so many definite and familiar paths, or series of interrupted bridges; and thus it progresses along these well known routes without hesitation when it wishes to pass through the forest from one place to another. In this way may be explained its extraordinary speed when in its home forest, where, as travelers have often related, it can pass along in the above way as fast as the hunter can run upon the ground beneath. In walking along the cylindrical logs it is constantly placing its feet upon the opposite sides of a rounded inclined surface, and in adaptation to this the feet become set at the ankles at such an angle that the soles face habitually inwards and downwards, partly facing each other. When, therefore, the animal attempts to walk upon the ground it must needs rest its entire weight upon the outer edge of its incurved feet, and thus makes its way along awkwardly and slowly.

This set of the feet and the habitual walking along the curved outer surfaces of horizontal limbs, with which the first stands in necessary correlation, is of great importance to the anthropologist, since the human foot shows the same

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of Borneo. There is also much in Hornaday, loc. cit. Chapter XXX. For the study of the races (varieties) of the orang-utan, cf. Selenka. Menschenaffen. Ltg. 1. 1899.

tendency, although to a much slighter degree. If, for example, the prints of a naked human foot, made when the person is walking perfectly naturally, be examined, as may be easily done by wetting the foot thoroughly and then walking across

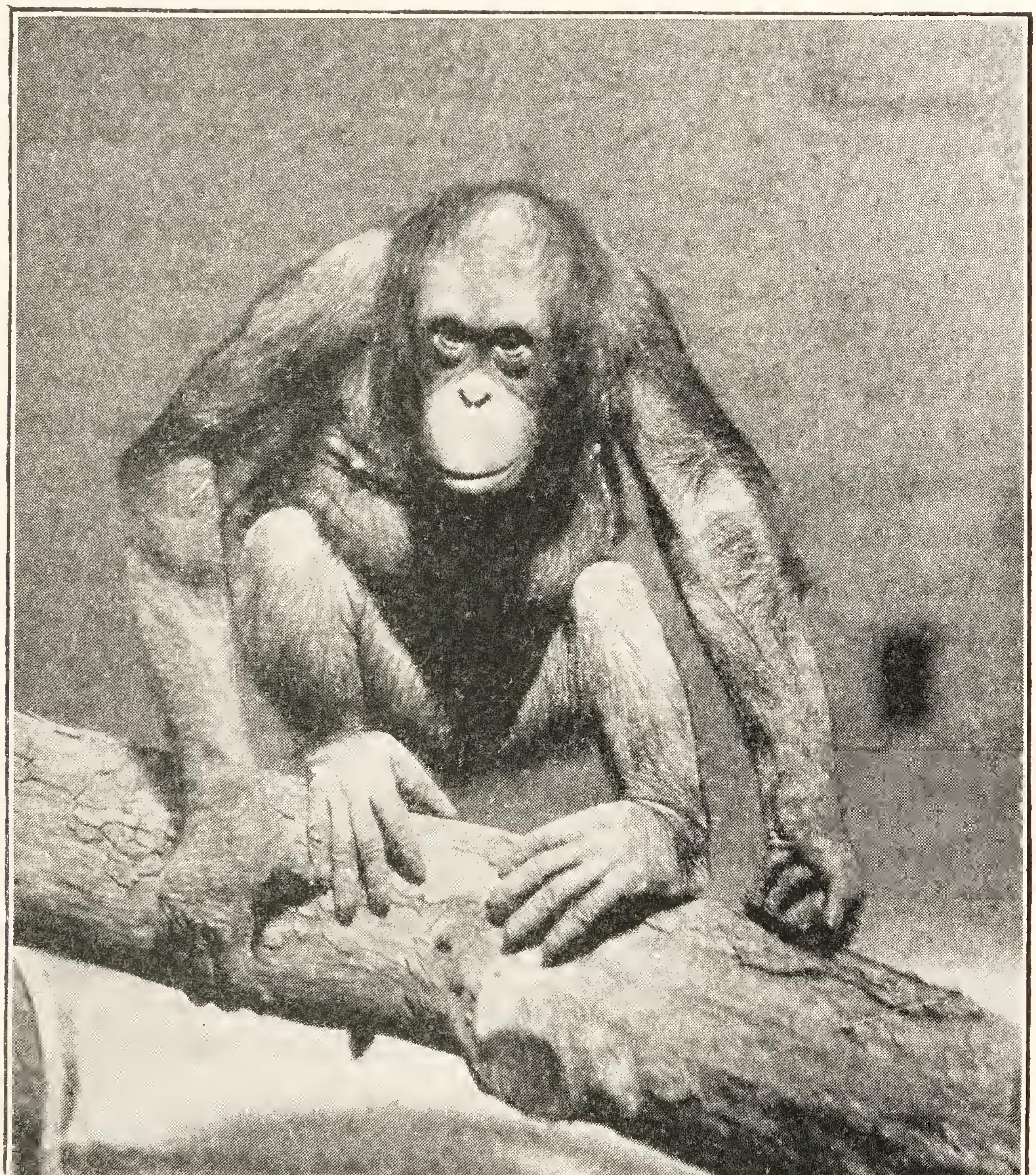

FIG. 11. Living Orang-utan of the more usual variety, with a narrow face. Photograph from the Zoölogical Park. Courtesy of the New York Zoölogical Society.

a polished hardwood floor, it will be seen that the contact is mainly that of the ball and the heel, connected by the outer edge of the intervening portion, while the inner part of the middle of the foot is raised clear of the floor. In young

infants this character is much more marked, as would naturally be expected with an ancestral trait, and both the true simian incurve at the ankle, and the tendency to bow the legs and apply the soles to each other, can be continually observed. (See Fig. 82). It is even possible that this tendency, fully as much as lack of strength, renders the first attempts at walking difficult for the human infant; its bearing also upon the frequency of bow-leggedness among young children, which is early "out-grown," is obvious.

The food of the orang, when in a natural state, is from necessity almost exclusively vegetable, but when occasion offers, the fledglings and eggs of birds, large insects, and even small dead animals are greatly enjoyed. When in captivity under as natural conditions as possible the usual board prepared for human beings proves wholly satisfactory, the ape seeming to enjoy, not only foods of high flavor, but also the variety and frequent change of diet made possible by civilization.[1] As the food habits of this species are much the same as those of the gorilla and chimpanzee they need not be further described under those heads.

16. THE GENUS GORILLA: THE GORILLA. This, the largest and fiercest of the anthropoids, occurs only in a somewhat

[1] Sokolowsky, Alexander; Beobachtungen über die Psyche der Menschenaffen. Frankfurt, 1908. Dr. Sokolowsky is the veterinary surgeon of the famous Hagenbeck Park, at Stellingen, near Hamburg, and gives here his experiences gained from the daily association with the large apes. Hagenbeck's own book also, "Beasts and Men," Longmans, Green and Co., New York, 1909, gives a short description, and good photographs, of these large apes. Sokolowsky reports that the food of the larger anthropoids at the Stellingen Park is the same as that used by the Hagenbeck family, and is prepared by the same chef.

DuChaillu, however, reports that the food of the gorilla is wholly vegetable, and bases his conclusion upon the examination of stomach contents in the case of numerous specimens shot in their native environment. Furthermore he asserts that it is mainly or wholly such as can be obtained when the animal is on the ground, and that it is not necessary to ascend trees for it. The gorilla is "fond of the wild sugar cane; especially fond of the white ribs of the pineapple leaf; and also eats the pith of some trees and a kind of nut with a very hard shell." Still it is likely that the absence of animal food is in great part due to the difficulty in obtaining it.

restricted region of tropical West Africa, between the equator and latitude 15° S.; extending from near the coast several hundred miles into the interior.

The first mention of this animal is found in the account of the voyage of Hanno, the Carthaginian, undertaken about the year 700 B. C. This account, preserved only in Greek, presumably a translation from a Phoenician original, states that this early explorer, starting from Carthage, followed along the coast of Africa, westwards through the Pillars of Hercules (Straits of Gibraltar) and out into the open ocean; where he seems to have turned southwards, following the coast for a long distance. In the course of this narrative occurs the following remarkable passage: " . . . On the third day, having sailed from thence, and passing the Streams of Fire, we came to a bay called the Horn of the South. In this recess was an island, . . . having a lake, and within this again was another island, full of wild men. Of these there were many more women than men; their bodies were covered with hair, and our interpreters called them *gorillas* (γορίλλας).[2] Pursuing them we were unable to capture any of the men, for all escaped by climbing the precipices, which they easily accomplished, from which they cast down stones at us; yet we captured three females, which, because they struggled with their captors, biting and tearing them, we killed, and, having skinned them, brought the skins home to Carthage."

According to Pliny these skins were hung up in the temple of Juno (Melchar?) and were still there when Carthage was taken by the Romans.[2] The narrative of the voyage was

[1] The name *gorillas*, which, in the Greek account, was probably transliterated directly from the lost Punic description, was undoubtedly obtained by Hanno from the natives, since the name in the Fan dialect is "nguyala," still quite recognizable.

[2] "Penetravit in eas (insulas) Hanno Foenorum imperator, prodiditque hirta feminarum corpora, viros pernicitate evasisse, duarumque gorgonum cutes argumenti et miraculi gratia in Junonis templo posuit, spectatas usque ut Carthaginem captam." Quoted from Pliny; Historia Naturalis, by Du-Chaillu, in Explorations and Adventures in Equatorial Africa, 1861, p. 391.

probably carved upon the walls of this temple, and the Greek translation was very likely made directly from this.

From this early time we hear no more of the gorilla for many centuries, and this story, like those of the pygmies of the interior of the continent, became disregarded and absolutely disbelieved. In the middle of the nineteenth century, however, the gorilla was rediscovered, but as several persons independently furnished the data the honor must be shared. The first known fragment of a gorilla obtained by civilized men in modern times was a skull, which, near the close of the year 1846, came into the hands of an American missionary of the A. B. C. F. M., stationed on the Gaboon river, the Rev. Dr. J. Leighton Wilson. This was given to Dr. Thomas Savage, a medical missionary, also an American, who upon his return, brought it to Boston. Obtaining another soon after, the skull of a female (whether from the same source or not we cannot say), he brought them both to Prof. Jeffries Wyman, the distinguished anatomist of the Harvard Medical School, and together they wrote a memoir on the new ape (Boston Journal of Nat. Hist., 1847, vols. III and IV). In 1851 an entire skeleton was sent to Philadelphia by another medical missionary, Dr. H. A. Ford. Europe was almost equally fortunate as America in obtaining information concerning the gorilla, as in 1848 Prof. Owen, the great English anatomist, published an account of some bones which he had succeeded in obtaining (Trans. Zoöl. Soc., London, 1848). In France some portions of a body reached Paris in 1849 through Gautier Leboulaye, which was studied by de Blainville and Is. Geoff. St. Hilaire; and in 1851 much better material was obtained through Dr. Franquet and Admiral Penaud.

In all these accounts of discovery, however, there seems to have been no white man who had an actual encounter with the gorilla, or who had ever seen a living one. The

This author, however, does not believe that the beast here referred to is the true gorilla, but probably the chimpanzee.

material was collected from the native blacks, and the early reports of the animal's habits and mode of life were evidently from the same source. Thus while technically the discovery of the gorilla as an animal species belongs to Savage and Wyman, and while the knowledge of its structure became gradually known through these and the others mentioned, the real discoverer of the living gorilla in its native wilds was the American explorer Paul Belloni DuChaillu.[1]

This daring spirit, born in New Orleans in 1838 of French parentage, undertook alone and unattended, while not yet twenty years of age, the exploration of the unknown hinterland of the French Congo, lying back of the mouth of the Gaboon river, and eventually accomplished a journey of many hundred miles, penetrating on foot, accompanied by only native companions, far into the interior (1855-1859). While those who had previously reported concerning the gorilla obtained their knowledge secondhand, or at the best obtained bones and portions of dead bodies from the native hunters, DuChaillu encountered the "King of the African Forest" in the center of his own kingdom, far from the settlements of even the natives, and shot him as they stood face to face, the first white man to have had such an encounter since the sea rover Hanno, and his doughty sailors.[2]

[1]Forbes, loc. cit. vol. 2, p. 184, reports that "in 1860 the first living individual reached Europe, and lived for some months in Wombwells Menagerie." This antedates by a little DuChaillu's spectacular meeting with the "King of the African Forest," but as we can find nothing further concerning this individual it is safe to assume that it was a young one or a female and that it probably came through natives.

[2]The narrative of this remarkable journey, including a vivid description of the gorilla, is entitled "Explorations and Adventures in Equatorial Africa," Harper's, New York, 1861. An abridged edition, incorporating also another book, "The Country of the Dwarfs," and written more in the style of a juvenile book, appeared from the same publishing house in 1903, bearing the combined name. This is good, but naturally does not give the details as fully as does the original work. A more scientific presentation of DuChaillu's studies of the large simians, which includes the gorilla and three species of chimpanzee, was published in Proc. Zoöl. Soc., London, 1861.

FIG. 12. Stuffed specimen of a gorilla, sent to this country by Paul B. Du-Chaillu, about 1860. This has evidently been a good specimen, but is now much faded and otherwise injured. It has, however, a great historical value, and is almost a type specimen, as it was one of the first that ever came to this country.

When, upon his return to America, DuChaillu had the chagrin of having his tales disbelieved, he made a second expedition (1863-1865) and brought back the actual bodies of no less than nine gorillas. One of these, made into both a skeleton and a stuffed specimen, is still in the Museum of Amherst College, and furnished the originals for Fig. 12 here given, as well as for Figs. 61 and 62. In the mounted specimen the taxidermist has represented the animal in the act of breaking in his giant hands the gun of a supposititious hunter, bending the steel barrel with ease. Such an incident actually did occur in one of DuChaillu's early gorilla hunts, where the beast, after mortally wounding a native assistant, turned his rage against the gun, and destroyed it. "The stock was broken and the barrel was bent and flattened" (loc. cit. ed. 1861, p. 342). This description is accompanied by a full page wood engraving, showing the gorilla standing in a defiant attitude, with the bent gun in its hand, and the taxidermist who mounted this specimen had this scene evidently in his mind. Thus, in a certain way, the Amherst College specimen figured here has become historic. It is one of the first specimens brought to America by DuChaillu, but is certainly not the one that bent the gun, as the specimen, in the narrative, although wounded, ultimately escaped.

Since the date of these early specimens the Gorilla has become a fairly well-known simian. It is the largest and strongest member of the Family, and, indeed, of all the Primates. An average adult male stands from 1700 to 2000 mm. in height (5 ft. 7 in. to 6 ft. 6.7 in.) and in this it must be considered that the legs of the gorilla are proportionately much shorter than in man, and that this height indicates a gigantic body, with enormous chest and shoulders. An extremely large specimen, even exceeding the extreme given here, has been recently placed in the museum at Hamburg, and is undoubtedly the largest yet known. It was killed in the forest near the station of Yacinde, German Kamerun, and stood 8 ft. 8 in. in height, with an arm reach of more than

Fig. 13. Gorilla gorilla; photograph of a young living specimen. Photograph from the Zoölogical Park. Courtesy of the New York Zoölogical Society.

9 ft. Its weight was in the neighborhood of 500 pounds. In comparison with this it is interesting to note that DuChaillu's maximum figures for height, received with general incredulity, was but 5 ft. 8 in., and the one that he afterwards procured for Dr. Jeffries Wyman of Harvard measured only 6 ft. 2 in. (cf. L'Anthropol. T. 12. 1901, p. 499).

The general color of the animal, both that of the sparse, coarse hair and of the skin surface beneath, which is in places very evident, is a dull black. The face is broad and the jaws are much less projecting than in the orang-utan, although they are extremely heavy and powerful, and are armed with heavy teeth. Huge supra-orbital crests hang over the eyes and continue across the nose; and as this latter feature forms a scarcely perceptible elevation, the two large, wide-open nostrils seem to lie flat upon the face.

Owing to its great bulk the gorilla is too heavy for an

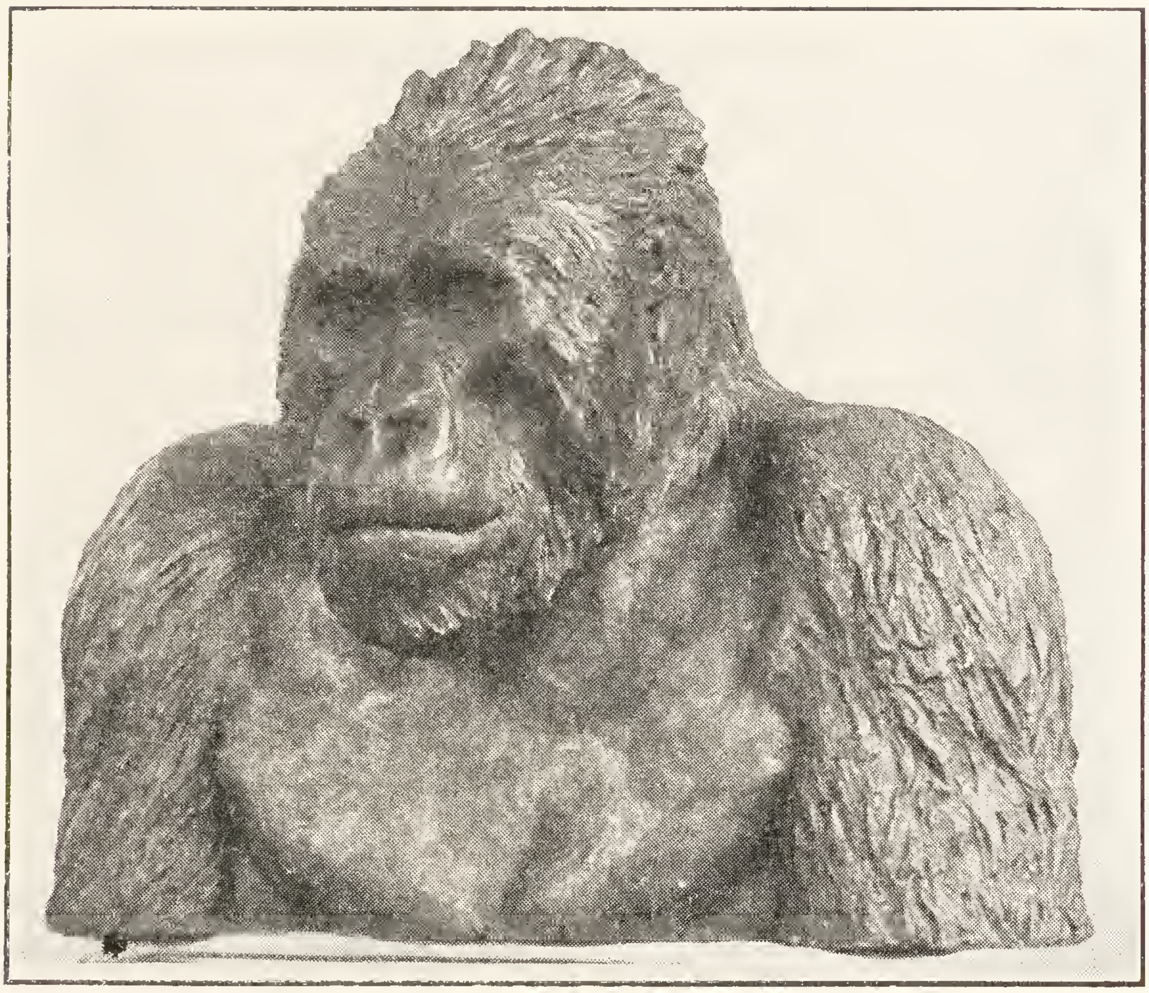

FIG. 14. Head of male gorilla, photographed from a bronze bust of "The Old Man of Mikeno." The bust was modeled from the freshly killed body by Carl Akeley, and, as no photograph of a living adult male has yet been possible, and all photographs of dead ones are unsatisfactory, is the best reproduction available. This photograph was taken from the bronze bust expressly for this book, under the direction of Mr. Akeley himself, and is thus an extremely valuable record of this rare animal.
Loaned the author by Mr. Carl Akeley.

exclusively arboreal life, and thus lives to a large extent upon the surface of the ground. It usually progresses by crouching on all fours, with the knuckles of the hands resting on the ground, but occasionally stands or walks erect, and when on the defensive or about to make an attack always assumes this position.[1] Its feet are not set obliquely at so extreme an angle as are those of the orang-utan, and the phalanges are straighter, so that it uses a greater amount of sole

[1] "The common walk of the gorilla is not on his hind legs, but on all-fours. In this posture, the arms are so long that the head and breast are raised considerably, and as it runs the hind legs are brought far beneath the body. The leg and arm on the same side move together, which gives the beast a curious waddle." DuChaillu, loc. cit. p. 398.

surface than the latter animal, although less than in the case of the gibbon.

Gorillas live in small families under the guidance of an old male, and at night the females and young climb the trees and lie in rudely constructed shelters while the males sleep on the ground beneath. Although an adult male has never been taken alive, females and young males have been repeatedly captured, but can never be made to live long in captivity, even under the most favorable circumstances. When captured they lose all spirit at once, eat little or nothing, but sit for hours in an apathetic condition until the end comes, which is always within a few weeks. At such times the attitude and the pitiable expression of their faces are as unmistakably signs of grief as any which Man can assume, and show plainly the development to a certain extent of a psychic life that must be reckoned with, the quickening of a mind by means of which a related species, less powerful physically, has mastered the world.[1]

17. The Genus Pan: the Chimpanzees. The word "chimpanzees" is used here in the plural since there are several well-marked species. The common one is *P. chimpanse* which has long been known, and more recently there have been added others, such as *P. schweinfurthi*, *P. calvus*, and *P. kooloo-kamba*, the two last discovered by DuChaillu. All chimpanzees inhabit tropical Africa, between the Equator and 15° S. Latitude. Thus the ranges of the two African apes, gorilla and chimpanzee, practically correspond, except that the chimpanzees extend a little farther north and south, and eastward entirely across the continent.

The chimpanzees are best described as lesser gorillas, for in their general physical characters they are so closely allied with these latter that some naturalists have proposed to place them in the same Genus. In general proportions the arms are shorter, and the legs are longer, than in any other member of the Family, all four limbs being of approximately

[1] Sokolovsky, Alex., loc. cit.

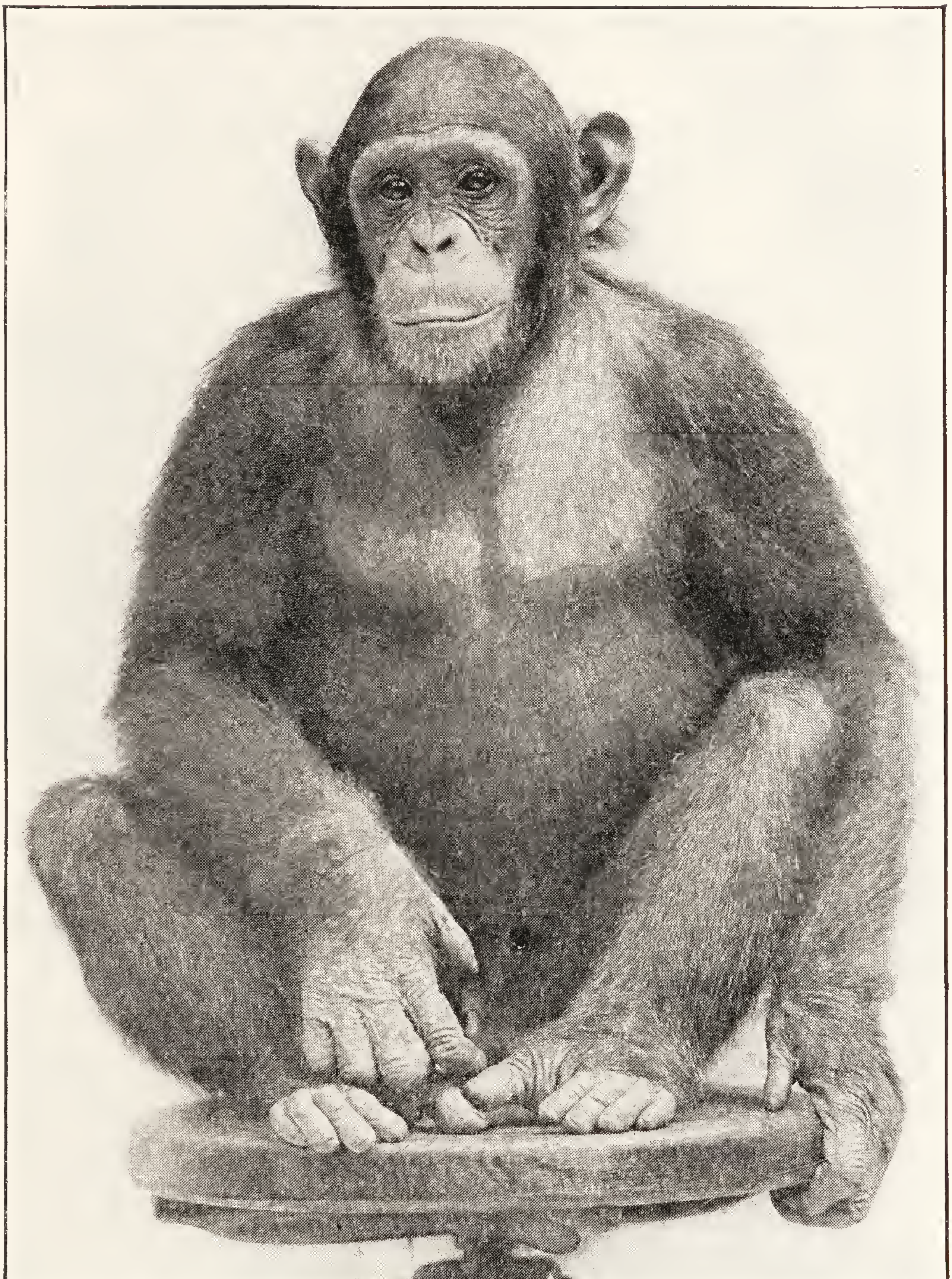

FIG. 15. Living specimen of *Pan chimpanse.*
Photograph from the Zoölogical Park. Courtesy of the New York Zoölogical Society.

the same length, the arms but slightly longer than the legs. In total height the animal may reach 1500 mm. (4 ft. 11 in.). The head is in general appearance something like that of a gorilla, but the outlines and surfaces are all rounder and

smoother. The jaws are not so heavy and the supra-orbital crests, although continuous across the middle, as in the gorilla, are less conspicuous. The external ears, which in the orang-utan are small and not conspicuous, and in the gorilla moderate, are in the chimpanzee very large. They are quite human in shape, even to the details, but stand out from the head so as to be almost at right angles with the surface at the point of attachment. The eyes are large and more human than in the other large apes; the teeth are moderate in size. The hair, which is sparse, is black in the species *P. Chimpanse;* black or dark brown in *P. calvus;* the skin color is, as a rule, black in the adults, and yellow or white in the young. The face and ears are naked, and in the species *P. calvus,* as expressed in the name, the head also is nearly so.

In habit the chimpanzees are more arboreal than the gorilla, but walk readily on the ground, without support from the arms. In the natural state the chimpanzees are monogamous, living in pairs and families. The chimpanzees are particularly favorable for study, as they are seldom fierce, and live in captivity very well, provided they are furnished with a moderate amount of freedom, and have sufficient opportunity to walk and climb about. They are easily trained, and readily learn to do many amusing things in a way that is strikingly human, but it may be doubted if by any such means one gains much knowledge concerning their natural instincts and manner of life. Thus they learn readily to eat at a table, and manage the associated implements with some dexterity, and it is very significant that they thrive upon precisely the same sorts and variety of food that would be given to human boarders. The orang-utan, also, when taken very young is equally adaptable with the chimpanzee, and the two species readily learn to associate together and apparently enjoy the mutual companionship. Both species also attach themselves to people, especially to those who have the care of them when young, and when deprived of all such association, either with men or with other

allied apes, they can no longer live contentedly, and either their bodily health will soon suffer, or they may even sicken and die. In this respect they furnish a sharp contrast to such animals as cattle and horses, which live contentedly when merely the bodily needs are satisfied, and show the presence of a developing psyche, a complex mass of emotions which demands recognition as well as do the material needs of the body. As truly as in Man, though of course to a far less extent, they require an intellectual as well as a physical, environment, and possess something that responds to such stimuli. There is great need of a careful psychological study of the higher apes, a study conducted sympathetically, yet under strictly scientific conditions, where neither sentiment nor bias, nor the almost universal tendency to view animals from an anthropomorphic standpoint, must be allowed to prejudice the results. It is a pleasure to record that such a study has already been inaugurated under the best possible conditions in the Hagenbeck Park at Stellingen, near Hamburg, under the control of the zoölogical director, Dr. Alexander Sokolowsky, and that in several other places, as at the Bronx Park in New York, opportunities favorable for such a study are being developed.[1]

18. Other Hominids, not yet fully known. Although the above enumeration includes all of Man's near relatives now known to be living, it is at least possible that the world in this respect is not as yet wholly known, and that there may still exist, perhaps in the lesser known parts of Africa, other species, or at least other varieties, than those with which naturalists are already acquainted. Indeed several scientific observations already point to the probability that in the future one or more such species may be established. Some of these doubtful cases are as follows:—

The "*Kooloo-Kamba.*" This ape was figured and described

[1] Cf. Sokolowsky, loc. cit.; also Hagenbeck, loc. cit. As this part of the manuscript was prepared previous to the World War, we cannot say as to present conditions.

by DuChaillu as one of the discoveries made by him in the Gaboon region, where he met with the gorilla. The name, given it by the Goumbi people, signifies its cry or call of "kooloo," joined to the word "kamba," which means "speak." In DuChaillu's original description he says, "This ape, whose singular cry distinguishes it at once from all its congeners in these wilds, is remarkable, as bearing a closer general resemblance to man than any other ape yet known. It is very rare, and I was able to obtain but one specimen of it. This is smaller than the adult male gorilla, and stouter than the female gorilla. The head is its most remarkable point. This struck me at once as having an expression curiously like to an Esquimaux or Chinaman. The face is bare and black. The forehead is higher than in *any* other ape, and the cranial capacity greater by measurement. The eyes are wider apart than in any other ape. The nose is flat. The cheek-bones are high and prominent, and the cheeks sunken and 'lank.' The ridge over the eyes is well marked. The muzzle is less prominent and broader than in the other apes. The sides of the face are covered with a growth of straight hair, which, meeting under the chin like the human whiskers, gives the face a remarkable human look. The arms reach below the knee. The hair on the arms meets at the elbow, growing upward on the fore-arm and downward on the arm. The body is hairy. The shoulders are broad; the hands long and narrow, showing it to be a tree-climber. The arms and hands are very muscular. The abdomen is very prominent, as it is in the gorilla. The ears are very large, and are more nearly like the human ear than those of any other ape." [1]

This description, although plainly the work of a very young naturalist, cannot be disregarded, especially since it has been repeatedly shown that the author was extremely accurate in his observations. The existence of this rare, and scarcely known, form throws much light on various

[1] DuChaillu; loc. cit. pp. 408–409.

problematic apes, some of which have been brought from this region alive, and have been exhibited in various animal parks, while others have afforded difficulties to investigators, when examined in a preserved state. A description of some of these problems follows, and in most cases an explanation is sought by suggesting an identity with the "kooloo-kamba."

"*Mafuka.*" This was the personal name given to a female specimen, brought originally from Loango, that lived for some years in the Zoölogical Gardens at Dresden, and concerning whose specific identity the authorities were uncertain. She was a "wild, unmanageable creature, 120 cm. in height . . . the face was prognathous; the ears were comparatively small, placed high on the skull, and projecting outwards; the supra-orbital arch was strongly developed; the end of the nose was broad; and there were rolls of fat on the cheeks."[1] She appeared at first sight to be a rather young female gorilla, but this view was opposed by some, who preferred in the main to class her as a chimpanzee. There is more or less support for the assumption that crosses between these large apes occasionally occur in nature, and it is thus quite possible that Mafuka was a hybrid, one parent being a gorilla, the other a chimpanzee; others think that she was a kooloo-kamba.

"*Johanna.*" This also is a personal appellation, and was borne by a large female ape, long exhibited by Barnum and Bailey, and regarded by them as a gorilla. She was made the subject of a scientific examination in 1899 by the English anthropologists, Keith and Duckworth, and was found by them to be undoubtedly a chimpanzee, but unlike the commoner species. What added to the difficulty was that she had cut her second teeth, and had otherwise matured, thus bringing her to a greater age than is usual in captivity, and emphasizing adult characters; furthermore, although there is never

[1] Hartmann; Anthropoid Apes (Engl. transl.). Internat. Sci. Ser. Appleton, New York. 1886. pp. 215–216.

any confusion between the males of the chimpanzee and the gorilla, the females are easily confused, so that the mistake of Johanna's exhibitors was but natural. Like Mafuka, which she greatly resembled, Johanna possesses many characters like the gorilla, and is undoubtedly of the same species as this problematic Dresden animal. In fine, Keith considers her a genuine kooloo-kamba, perhaps a variety of *P. Chimpanse*, perhaps a distinct species, and calls her *"Anthropopithecus troglodytes kooloo-kamba."* [1]

Duckworth's specimen; Cambridge Museum. This case is worth citing here, not because the specimen is, in itself, a famous one, but because it well illustrates the difficulty that still exists in the determination of the species and varieties of these large anthropoids. The specimen in question was an old female, collected in the region of the Gaboon river, West Tropical Africa, at the home, therefore, of both the gorilla and the chimpanzee. It was sent in the flesh, indifferently preserved, and was carefully dissected by Dr. Duckworth. As a result of this investigation it was found to differ in certain important points from both gorilla and chimpanzee, while at the same time it was equally distinct from Mafuka and Johanna, just considered. In the final report of this investigation, published in 1904, the author finds it impossible to give it a definite place among the well-known species, and suggests two alternatives; either that it is the "kooloo-kamba" of DuChaillu while the others are not, or that it may be a hybrid form, between gorilla and chimpanzee, but of a different type from that to which "Mafuka" and "Johanna" belong.

This last instance is an especially valuable one, as it represents the insufficient state of our knowledge concerning the great man-like apes. It is not even determined in the case of the well established species enumerated above whether the numerous varieties recognized by the natives are merely

[1] Keith, A. On the Chimpanzees and their relationship to the Gorilla. Trans. London Zoöl. Soc. March, 1899. pp. 296–312.

varieties in the zoölogical sense, or should be raised to the rank of species. A conservative estimate gives one established species of orang-utan, two species of chimpanzee, and one species of gorilla, but it is quite possible in any of these cases to find well-marked varieties, sufficiently distinct to have won for themselves distinct names among the associated natives, and if these be found to remain distinct from each other, with constant differences, not only in structure but in habits and environment, their elevation to the rank of species will be necessary.[1]

19. Native Names for the Different Simians. It is of much importance, especially as an assistance in the identification of forms mentioned by travelers, to consider some of the names by which the various simians are known in the local languages. Such a consideration must, by the nature of the case, be far from complete, since the animals in question occur for the most part in association with very primitive peoples, where dialects may differ at every village, and where these become distinctly different languages within slightly larger ranges. Certain of the numerous appellations have, however, been selected by travelers, some of whose observations have become classic, and it is these which are of especial importance. Among many native names may be mentioned the following:—

Hylobates. For the large syndactyl form, the Malay name "si-amang" is commonly used. The other forms are distinguished for the most part by the distinctive and characteristic cry, which these animals repeat in chorus. Thus *H. leuciscus* is the "wau-wau," and the specific name of the species *H. hoolock* (or hulok) is the name given it by the natives, also an attempt to imitate the cry of this species.

Pongo. The two commonest names associated with this species are the Malay expression "orang-utan" (man of the forest), and the name "mias," or "maias" (German spelling), the name given it by the Dyaks, who inhabit the interior of

[1] Cf. Selenka, loc. cit., for varieties of the Orang-utan

Borneo. These people further distinguish the different varieties by qualifying terms, as "mias pappan" for the larger variety with the broad cheek fold, and "mias kassu" for the smaller. They have also the words "zino" and "këu."

Gorilla. The native name most frequently associated with this animal is the word "gina,"[1] used, for example, by Is. Geoff. St. Hilaire in 1852 as the specific name (*Gorilla gina*). This word, although in this form somewhat corrupt, is easily recognized as the word spelled "njina, njeina, indjina," in accordance with the dialect and the acuteness of hearing of the explorer. This is the word used by the Mpongwe, Orungu, Bakalay, Galloa, and Kamma tribes. In the language of the Fan tribe, however, the word is "nguyala" or "nguyla," evidently the original of the word reported by Hanno, and handed down to us in its Greek form, γορίλλα. The English seaman and traveler, Battell, in 1613, calls a certain large ape, doubtfully identified with the gorilla, the "pongo," obviously the "n'pungo" or "m'punga" of the Loanga natives, with whom he was associated.

Pan. By the tribes in the Gaboon district, the Mpongwe, Orungu, Kamma, Galloa, the name applied to the chimpanzee is variously given as "nschiego, nschego, ndjeko," without doubt the "enjeco" of Battell (1613). Among the Aschiva and Mahimba the name is "kulu"; among the Niam-Niam it is "ranga" or "mandajaruma," and among the Avahis it is "bam" or "m'bam." The variety described by Dr. Livingstone under the Manuyema name of "soko" has been considered by some a distinct species, at least a well-marked variety. DuChaillu's species, *P. calvus*, the "bald chimpanzee," was so named from the native (Kamma or Anengue) word "nshiego-mbouve," which seems to have the same significance. The kooloo-kamba (=the one saying "kooloo") probably belongs near here.

It would seem that these native names are applied more

[1] With a soft g, and the Italian i.

accurately and with far more precision than are the English names in common use, and for that best of reasons, a more precise knowledge of the objects involved. From the time of Battell's reports concerning the pongo and the enjeco, published in 1613, and from the period of Tulpe's anatomical treatise on the "*Satyrus Indicus*" or "*Homo Sylvestris*" (undoubtedly a Chimpanzee), in 1641, reports have been much confused, and it has been almost within our own time that the Genera and Species of the known simians have been clearly distinguished. Even now the knowledge on this point does not appear complete, as has been shown in the preceding section, and the more complete exploration of the little known parts of the tropics of the Eastern Hemisphere may still yield new living species of this most important Family.

There is no doubt that Battell's words, pongo and enjeco, have the priority respecting time, but there is doubt concerning the animals meant by them. Enjeco is undoubtedly the same as DuChaillu's "nshiego," the name he uses for the chimpanzee, and we may suppose that Battell's "pongo" was meant by him to designate the gorilla, an associated animal occupying the same country. Nshiego is evidently the word "Jocko" or "Jacko" long used as the individual name of pet monkeys, and easily derived from the native African name.

Elliot, following the law of priority, uses the word "pongo," first applied to some large African ape, on the authority of Lacépède, who designated the orang-utan by this word in 1799, and thus antedates all others. Revisions of names are unfortunate, especially so when the name applied by an adventurer to an African animal becomes used to designate an Asiatic one, but if Elliot has correctly followed the law upon which our present revisions are based, it may be expected to continue.

20. The Genus Homo: Man. In this genus, anatomically closely related to the preceding, is placed the Man of the

present day, the animal which of all others has gained the control of the world and its forces. Zoölogically considered, the numerous races of men, the types familiarly called "Ethiopian," "Mongolian," "Caucasian," and the like, are

FIG. 16. *Homo sapiens*, an American Indian baby, 18 months old, photographed at the Tewa Pueblo, New Mexico. His personal name is "Agapito," and he is busily engaged in studying, and perhaps tasting, a butterfly. Photographed by Miss Harriet Andrews.

held to be no more than well-marked varieties of a single species, and although for convenience ethnologists sometimes make use of the old Linnaean terms, *Homo ethiopicus, Homo americanus,* and so on, they are not used in the zoölogical sense as denoting distinct species. This single species, to which all living varieties of men may be referred, has been

named with an egotism perhaps slightly questionable, *Homo sapiens.* Other closely related species, one at least, *Homo neandertalensis,* belonging in the same Genus, are known from their remains, but they became extinct during the establishment of the present species, and more than likely because of his success.

CHAPTER II.

RELATED EXTINCT FORMS

21. The Condition of the Paleontological Record. As everywhere among both plants and animals, the species living upon the earth at the present time, or, in fact, at any one epoch of geological history, represent more or less isolated groups of forms, the relationship between which is indicated only by structural similarities and differences, often, indeed, obscurely enough. The numerous connecting forms, through which the different animal groups are bound together, are not all contemporaneous, and in cases where many of the stages have been entirely lost the isolation from one another of separate animals and animal groups is often extreme. Thus the view of the contemporaneous forms of any one geological period is a sort of cross-section of the phylogenetic tree, which in some places happens to coincide with two diverging branches while still near each other, or occasionally even with the point of separation, that is, a common ancestor of two diverging branches; but more often cuts branches widely separated from each other and from the parent stem, so that the chance of correctly deducing from their relative position the course of the connection lower down is very slight.

All attempts, therefore, to relate the different living forms of any group of animals, brilliant though they may be, and resting upon however thorough a knowledge of the anatomical structure of the forms studied, can never pass beyond the grade of plausible hypotheses unless they be reinforced by all the information obtainable concerning the extinct members of the group. Again and again have the most widely accepted beliefs concerning the interrelation of living animals been overthrown, or at least profoundly modified, by the chance discovery of some fragment from mine or quarry,

upon which was clearly and positively drawn the actual structure of a common ancestor.

The ancestral history of the group of Primates, especially in its early parts, is still very imperfectly known, and although the few fragmentary remains already discovered are of incalculable value, and enable us to reconstruct a few portions of the history with some degree of certainty, some of the most fundamental questions remain unanswered. In the case of many other mammals, like the horse, the ox, the elephant, and the camel, nearly the complete line of descent has been found, and the gradual acquirement of their highly specialized features may be followed step by step upon the actual remains of the ancestors which constituted the stages in the process of development; in the line of the Primates, however, the record is very incomplete, and many of the stages in the development are still matters of controversy, perhaps the surest evidence of imperfect knowledge.

This state of affairs, the failure of the data concerning that very line of descent which interests us the most, is attributable to several causes. In the first place the line of the Primates is a very old one, reaching well back to the beginning of the Eocene, or even further; probably, indeed, into the Cretaceous, a period of immense duration from which, as yet, save at the very end, and possibly again at the beginning, not a single fragment of mammalian origin is known to us. Again, the earlier Primates were all small animals, many of them no larger than squirrels, and never exceeding the bulk of a rabbit until perhaps the middle of the Miocene; and the odds against both the preservation and the later discovery of the delicate parts of such animals are naturally very great. In fact nearly all the parts known of any of them are fragments of jaws containing the molar and premolar teeth, lower jaw halves being by far the most frequent. The frequency of these parts, together with the almost complete absence of any others, have led to many speculations

concerning the reason for the phenomenon. The most obvious one is the fact that these are the hardest parts, but this would not explain the more frequent occurrence of the lower jaws; and it has been suggested that in a small carcass floating on water the mandibular halves would become easily detached from the rest through decay, and would drop to the bottom, where they would receive a deposit of the silt suspended in the water, and would thus be preserved. It may also be pointed out that if these small animals were eaten by other animals, the front of the head, containing the teeth, would be so hard that it would be either left, or else rejected from the stomach, as is frequently the habit with carnivorous forms, both birds and mammals.

Aside from the difficulty of preservation of such small remains their minuteness of size becomes in itself a third reason for the lack of better representation in our museums, a reason wholly economic, and thus the more a matter of regret. In most cases valuable fossiliferous deposits lie in regions difficult of access (e. g., the "bad lands") and the collection of fossils is attended with so much expense that only through the munificence of an institution or of a wealthy patron, can an expedition be properly equipped. These patrons, as well as the general public, through whose aid alone such expeditions become possible, have so long had their attention focussed upon large animals, especially those of absolutely titanic proportions, that they have come to expect results of large dimensions, skeletons which will necessitate alterations in the architecture of the exhibition halls, or the building of new ones; and so strong is the appeal produced upon most men by mere size that the money for such alterations, in addition to that for the original expedition, is readily supplied, while the far more important fragments of the ancestors of the human race are collected only as a sort of by-product, and when placed on exhibition are consulted only by specialists. It may be hoped that in the

near future the philosophical appeal of the remains of early Primates and the increasing interest in the pedigree of Man may direct the attention of the patrons of science in this direction, and that through their aid the all important problem of human phylogeny may receive a more complete solution.[1]

22. THE CHRONOLOGY OF MAMMALIAN HISTORY: THE MAIN DIVISIONS. As the early history of the development of the Primates involves that of the mammals in general, this larger subject may be best introduced by making a rapid survey of the chronology concerned as expressed in the geological subdivisions of time. In this way the relative dates of the various events considered, chiefly the appearance and extinction of certain forms, may be fixed, a most important consideration in the present discussion.

Only during that portion of the earth's history in which were formed the deposits that bear the remains of animals and plants can there be any definite estimate of the lapse of time. For the vast Archean Period during which were formed the deposits that have since reformed and crystallized into rocks bearing the general name of "granites," a transformation which has forever obliterated all traces of the life once contained there, we have mainly the data furnished by astronomers and physicists, who cannot make more than very general estimates. Beginning, however, immediately above these granites, the sedimentary deposits laid down in the form of strata, and containing here and there organic remains, furnish by their thickness, their relation to one

[1] A practical expert in the field of paleontology, the leader of many expeditions to the rich fossiliferous deposits of the West, once stated in an informal conversation that he always felt like making a conscientious attempt to procure in an expedition the sort of specimens that his patrons expected, and for which they had given their contributions. Primate material was there, perhaps in abundance, but its excavation was very slow and painstaking, and the results, although of the utmost importance, likely to be meager; thus he had to forego such investigation for the most part. Now that the attention is focussed upon large animals, one must not spend the people's money upon the acquisition of a booty so small in bulk that it can be brought home in a cigar-box.

another and the estimated rate of formation, somewhat more definite data for a division of the time into periods of definite relative duration.

As a fundamental division of this sort the entire time consumed in the formation of the sedimentary rocks of the world has been divided into four great, though very unequal, periods of time called *Epochs* or *Eras*, the *Primary, Secondary, Tertiary*, and *Quaternary*. Of these the two first are more commonly termed respectively, *Paleozoic* and *Mesozoic;* for the third the term *Cenozoic* is occasionally used, although not so commonly as the term "Tertiary"; and the fourth, Quaternary, is sometimes considered as including the present time, but is more often employed in a restricted sense, and does not include the "Recent" period, in which the very latest and most superficial events, like the formation of the alluvial plains of the present-day rivers, have been and are being completed. In point of relative duration these periods are very unequal, the length increasing in direct proportion to the age. Thus the Quaternary Epoch is practically modern history, since it reaches back only to the beginning of the Glacial Period, a date variously estimated at from 200,000 to 500,000 years ago. The Tertiary must have been many times as long as the Quaternary, its entire duration being estimated in millions of years rather than in hundreds of thousands, in all perhaps between one and three millions. Farther back than this it is better no longer to attempt to make the estimates in time even in millions of years, but in the relative thickness of the respective strata, which will give general indications of the relative duration of the periods. Estimated in this way the Mesozoic Epoch may be set down as three or four times as long as the Tertiary and the Paleozoic as two or three times as long as the Mesozoic, while the entire lapse of time occupied in the formation of the stratified rocks, the only period for which we have any data, may be estimated as between thirty and fifty millions of years. This estimate is not very

accurate, it is true, but it seems advisable to state it, even with such wide limits, as an attempt to counteract the popular tendency, indulged in especially by the newspapers and magazines, of expressing these time estimates in hundreds of millions of years, or even in wilder guesses, which become mere figures of rhetoric, and of no value at all as statements of fact.

The oldest known animal remains that exhibit mammalian characters occur in the older Mesozoic deposits belonging to the Triassic Period, and hence from about this point on the smaller subdivisions of the chronology will be of interest here. The Mesozoic Epoch is divided into three main Periods, the Triassic, Jurassic, and Cretaceous, in addition to which are found certain American deposits, like the Laramie, a little later than the European Cretaceous and still not to be considered Tertiary. These deposits, pending a more detailed settlement of the chronology, may be placed in a Period of their own, the Post-Cretaceous. Crossing the boundary into the Tertiary, this latter Epoch is seen to be divided into four Periods, the Eocene, Oligocene, Miocene, and Pliocene, four Periods of the utmost importance in the history of the Primates, and indeed in that of all mammals.

Lastly comes the Quaternary Epoch, almost contemporaneous history, geologically speaking, ushered in over the northern continents by the coming down of the Great Ice, a movement which began in the far North, and experienced several partial retreats and advances before its final withdrawal. This great event conveniently divides the Quaternary in the north into the Glacial and Post-Glacial Periods, often called respectively the Diluvium and the Alluvium, but over a great part of the world, where the ice never came, this distinction does not exist, and the divisions are here established by the estimated contemporaneity of the strata with those of the north. The older portion of the Quaternary is also called by some the Pleistocene, after the analogy of the Pliocene and the other Periods of the Tertiary

	Main Divisions of Time	French (gen'l)	British	American	European Mammals	American Mammals
TERTIARY	Pliocene	Sicilian Astian Plaisancian	Cromer Forest Norwich Crag Coralline Crag	Sheridan Loup River Equus beds Blanco	[Pithecanthropus; Java] Dolichopithecus	
	Miocene	Pontian Sarmatian Tortonian Helvetian Burdigalian	[wanting]	Loup Fork Florissant Deep River John Day	Mesopithecus Dryopithecus Pliopithecus Oreopithecus Opossums; East European records	
	Oligocene	Aquitanian Stampian Sannoisian	Hampstead Bembridge Osborne	White River { Protoceras beds Oreodon beds Titanotherium beds	Opossums (Peratherium)	Opossums
	Eocene	Ludian Bartonian Lutetian Ypresian Sparnacian Thanetian	Upper Bagshot Bartonian Bracklesham Lower Bagshot London Clay Woolwich, Reading Thanet	Uinta Bridger (upper) Bridger (lower) Wind River Wasatch	Necrolemur Adapis Plesiadapis, Protadapis (Introduction of Eutherian mammals into Europe)	Notharctus, Hyopsodus, Hemiacodon Microsyops Opossums (Peratherium) Tetonius Washakius Pelycodus Hyopsodus, Mixodectes
				Torrejon, Puerco (Basal Eocene)		Neoplagioaulax, Ptilodus Meniscoëssus, Solenacodon
CRETACEOUS	Transition	Danian	Upper Chalk	Laramie		(Introduction of Eutherian mammals into North America)
	Neocretaceous	Senonian Turonian Cenomanian	Middle Chalk Lower Chalk	Fox Hill Fort Pierre Niobrara Dakota	No remains of Eutherian mammals yet found during this period in either Europe or North America	
	Eocretaceous	Albian Aptian Barrenian Neocomian	Greensand (upper) Gault Greensand (lower) Wealden	Potomac		

Main Divisions of Time		French (gen'l)	British	American	European Mammals	American Mammals
JURASSIC	Neojurassic	Aquitanian Bononian Kimmeridgian Sequanian Oxfordian Callovian	Purbeckian Portlandian Kimmeridgian Corallian Oxfordian	Camarasaurus beds? Como beds? Lower Potomac? Atlantosaurus beds	Phascolotherium, Spalacotherium Triconodon, Plagiaulax	Ctenacodon Triconodon
	Mesojurassic	Bathonian Bajocian	Cornbrash Forest Marble Great Oölite Inferior Oölite		Amphitherium; Amphilestes	
	Eojurassic	Toarcian Charmouthian Sinemurian Hettangian	Upper Lias Middle Lias Lower Lias	Baptanodon beds		
TRIASSIC	Transition	Rhetian	Rhetian		Microlestes	
	Neotriassic	Juvavian	Variegated Marls Upper New Red Sandstone	Connecticut Valley Red Sandstone		Dromatherium; Microconodon
	Mesotriassic	Tyrolian Dinarian	Conglomerates	Star Peak		
	Eotriassic	Jakoutian Gandarian Gangetian	Red and Mottled Sandstones	Newark		
PALEOZOIC						

Fig. 17. Diagram showing the chronology of Geologic time since the beginning of the Mesozoic, with the correspondence between the formations of Europe and North America.

Epoch, after which comes the "Recent" Period. The words Pleistocene and Diluvial are thus almost synonymous terms, with which the word Quaternary, as used by some writers, may be also placed, all being the equivalent of the Ice Age or Glacial Period. The alternate retreats and advances of the ice sheet somewhat conveniently divide the entire Ice Period into several Glacial and Inter-Glacial Periods, subdivisions which are of much use in the prehistory of early Man.

Thus the *Homo heidelbergensis* probably lived during the Second Inter-glacial Period, that of the Mindel-Riss, while remains of the Neandertal type (*H. neandertalensis*) are contemporary with the last great glacial advance, that of the Wurm Ice.

23. The Chronology of Mammalian History: the Subdivisions. The geological Periods, such as the Cretaceous or the Eocene, are subdivided into smaller divisions of time which may be called Stages or Formations, each established upon a certain definite deposit, and arranged in chronological series. The deposits which give the name to the successive formations are usually those rendered prominent through the labors of distinguished investigators, but the establishment of an international chronology upon this basis is rendered difficult through the fact that there are often contemporary and equally famous deposits in widely separated regions, and that convenience, as well as a certain amount of national pride, impels the geologists of a given country to use a chronology based upon local geographical names. Furthermore it is far from easy to compare the deposits of two continents with respect to their relative age, and the comparison of a series based upon North American deposits with one worked out for Western Europe for example is fraught with serious difficulties, which involve technicalities. It thus happens that for a definite Formation or Stage in geological history there are numerous approximate synonyms, although none of them may exactly correspond.

In spite of these difficulties, however, a fairly universal chronology has been established for the deposits of Europe, and a corresponding series for North America; the correspondence in time between the two is also approximately agreed upon. For South America, where within a few years a large amount of important paleontological work has been accomplished, matters are still in an uncertain state, and for the important localities in Argentina and Patagonia the correspondences with the deposits of North America and Europe have not been fully established. These smaller subdivisions of geological time, beginning with the Triassic, which will include the entire history of Mammals, are given in the accompanying table (pp. 84 and 85). It shows the sequence of stages most commonly used, both for Europe and North America, with the probable correspondence of age.[1]

It will be noticed that the names of the European Stages, as given here, contain a large proportion of French localities, a circumstance due in part to the presence of extremely important deposits of the later geological times within the boundaries of France, and in part also to the prominence of the French in the attempt to establish a universal European chronology. Especially in the case of important localities the other nations of Europe are still much inclined to use the local names, and an absolutely universal chronology in actual practice is as yet far from being established. The American names bear for the most part the stamp of the West Central States, and will constantly remind the reader that the great mammalian deposits of the late Mesozoic

[1] The contemporaneity of strata in different parts of the world is always a difficult problem, and can usually be only approximately determined. For this an excellent work is Geikie's Text-book of Geology, 4th ed., 1903 (Macmillan). For the chronology of the European strata, as used by the French, cf. De L'Apparent, Traité de Geologie, 1906, 3 vols. The British strata, in tabular form, are given in a chart, published by Dulau, London, in 1901. In America Osborn has made special effort to compare the deposits of the two continents, especially of that period which includes mammals, and expresses his ideas in the pages of his "Age of Mammals" and his "Evolution of the Mammalian Molar Teeth," 1907.

and the Tertiary are located in the Western half of the United States, although the important Tertiary and Triassic strata of the Atlantic seaboard must not be forgotten.

24. The Beginnings of Mammalian History: Triassic Mammals. The most noticeable skeletal characteristic of mammals is their heterodont dentition, that is, the differentiation of their teeth into different sorts designated for different uses, incisors, canines, premolars and molars.

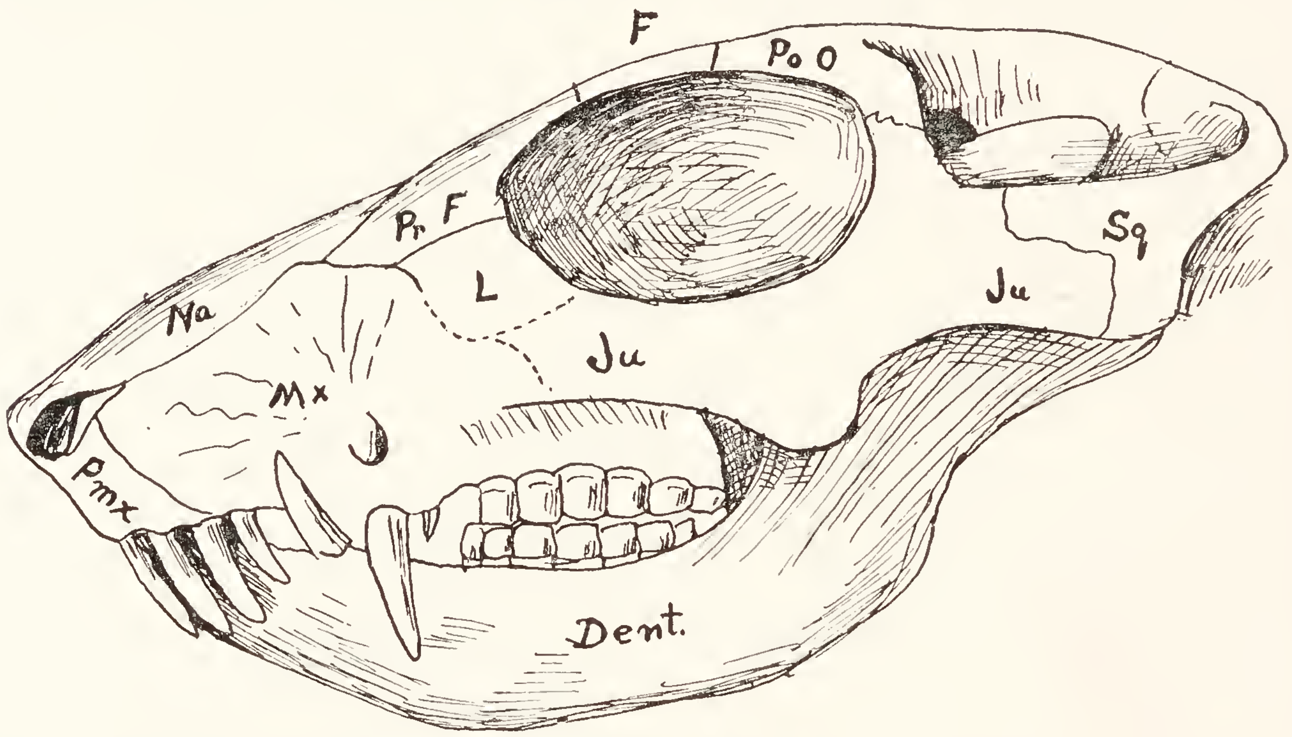

Fig. 18. Skull of *Sesamodon browni*, a Cynodont reptile (Theriodont), showing a strong resemblance to that of a mammal. After W. K. Gregory.

In contrast with this other Vertebrates have homodont dentition, with the teeth all alike or nearly so, and do not show such a difference. There are known, however, several extinct reptiles, the Sub-Class Synapsida, that had dissimilar teeth, and these often arrange themselves into groups strikingly similar to those of mammals. Since these animals also show many other characters in common with mammals it is generally believed that somewhere among these we may find the direct ancestors of the mammals. If we compare Fig. 18, the skull of a therapsid,[1] with that of any typical

[1] Gregory, W. K.; Critique of recent work on the morphology of the Vertebrate skull, especially in relation to the origin of Mammals. Journ. Morph. Vol. 24. March, 1913. pp. 1–42, 25 Figs.

mammal, we cannot help the feeling that here we are somewhere near the place of origin of the Class of mammals, and find that both here among the therapsids, and among other fossils, that are known to be true mammals, yet reptilian in many characteristics, we experience the same difficulty in classification that always exists when we study transition forms.

The oldest known remains that possess unmistakable mammalian characteristics consist of two mandibular

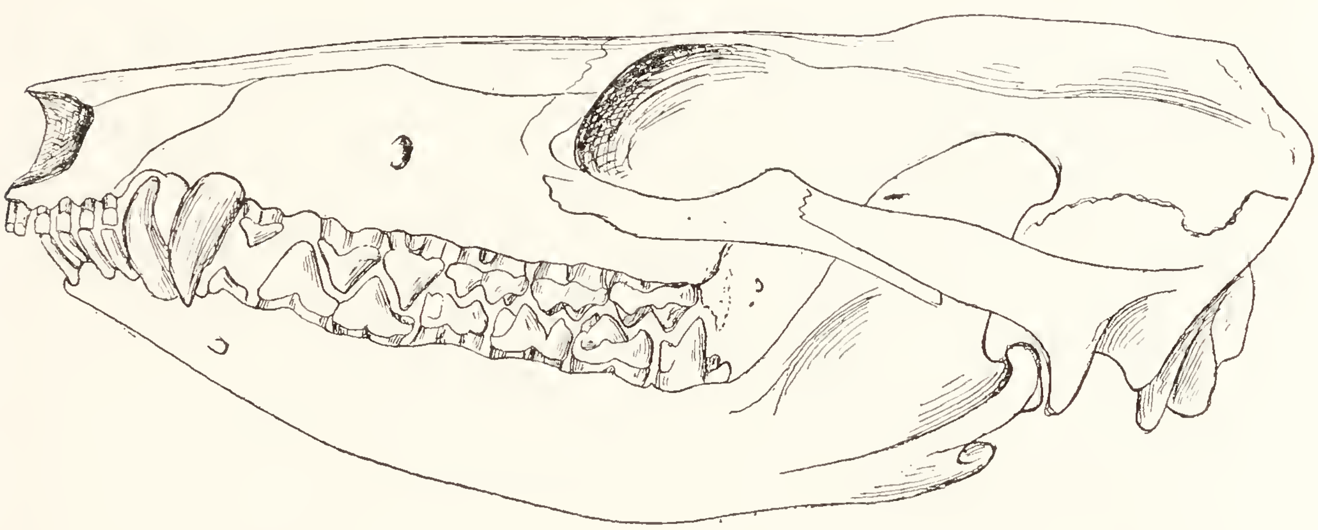

Fig. 19. Skull of *Didelphys americana*, the common opossum. For comparison with the previous figure.

halves of very small animals, found by Emmons in 1857 in the Upper Triassic coal beds of North Carolina. They are quite unlike any other mammalian jaw-bones known, and might readily be considered reptilian, except for the fact that the jaw itself consists in each case of a single piece, and does not show a separation into the separate elements, dentale, angulare, etc., as in the case of the reptiles. The two specimens were supposed by the discoverer to belong to the same species, which he named *Dromotherium silvestre*, but a more careful examination reveals differences enough to place the two jaws in separate Genera, if not further apart. The larger and better preserved specimen, used by Emmons as the type, is now in the Museum of Williams College; the other, proven by Osborn to be generically distinct, and

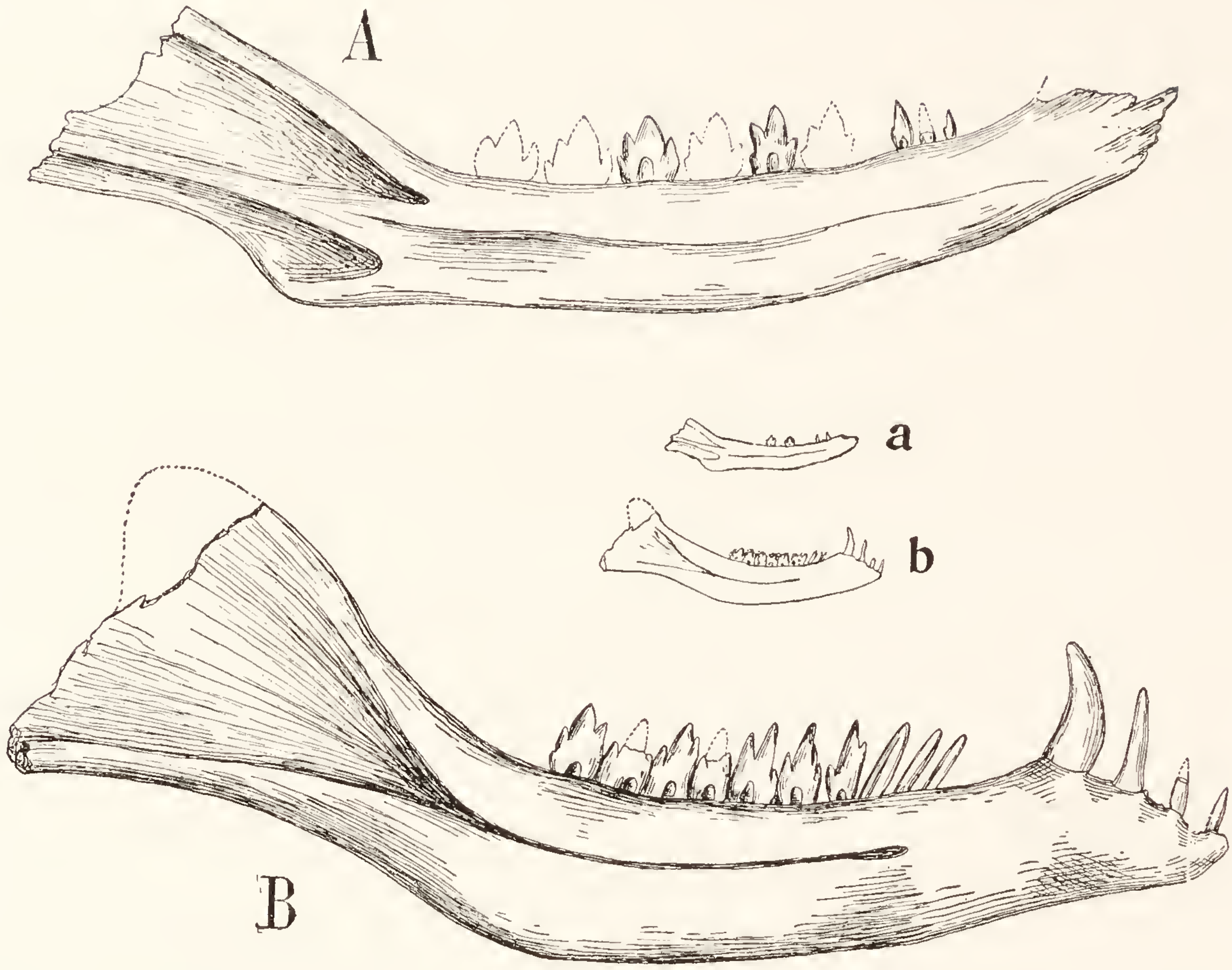

FIG. 20. The only known fragments of Triassic mammals, from the Upper Triassic of North Carolina. After Osborn. (A) *Dromatherium;* outer side of right mandibular half. (B) *Microconodon;* inner side of left mandibular half. The small outline figures, *a* and *b,* show the actual size of the specimens. *Dromatherium* is in the collection of Williams College; *Microconodon* in that of the Philadelphia Academy.

named by him *Microconodon tenuirostris,* is in the Museum of the Philadelphia Academy.[1]

In studying the details of these two remarkable jaws (Fig. 20) one is at once struck by their strong reptilian character. This is shown by the low coronary process, the

[1] The original paper of Prof. Emmons was published in American Geology, Part VI, pp. 93–94. Of the two jaws, from the Triassic of North Carolina, the type specimen, *Dromatherium,* is in the Collection of Williams College; the other, supposed by Emmons to be the same species, is in the Academy museum, Philadelphia. There was also a third fragment, but it is now lost, or at least its locality is unknown. Osborn, Proc. Acad. Nat. Sci. Phila. 1886. p. 359, subjected these specimens to a careful examination and pronounced them at least generically distinct, retaining the original name of *Dromatherium* for the Williams College specimen, which corresponded most closely to the description of Emmons, and placing the other in the new genus *Microconodon.* For a recent account of these jaws cf. Osborn, H. F., Evolution of Mammalian Molar Teeth. Macmillan 1907. pp. 18–21.

shallow curve of the entire outline, without angle or ramus, and, especially in *Dromatherium*, by the distinct groove for the mandibular (Meckel's) cartilage, which in the recent state must have been quite as distinct as in some modern reptiles, the turtle, for instance. The molar teeth also, with but a suggestion of a separation of the root into two fangs, are in this respect more reptilian than mammalian, and in *Dromatherium*, the more primitive of the two, all the anterior teeth, including those which, by their position, would be called incisors, canines and premolars, are styliform, as in reptiles, and not differentiated in shape from one another. The total number of teeth, also, ten cheek teeth in *Dromatherium*, make a probable total of 56, or even a larger number. This is much in excess of that of any modern mammal, and is also strongly suggestive of the reptiles. The form of the molar teeth is, however, peculiar. They are flat, with a serrated edge, which is divided into from three to five pointed cusps, all of which lie in the plane of the jaw; in *Dromatherium* these cusps are pretty definitely three in number in each tooth, with, perhaps, one exception. Such molars are not found in any reptiles so far as we know, but are in general effect similar to those of the more typical early mammals, in which they appear always with three definite cusps, the *protocone*, *paracone*, and *metacone*. In these earliest forms the number of cusps does not seem definitely fixed at three, although this number is already emphasized, and it is possible to see here the initial experiment that led to the definite tritubercular type of the later mammals.[1]

These two small fragments alone, then, form definite

[1] During the proof-correction of the present volume information has just appeared, through the Associated Press (Sept. 13, 1925), that the American Museum Mongolian Expedition, under the leadership of Dr. Roy Chapman Andrews, has just found in the Gobi desert the fossil remains of the oldest known mammals, one a Marsupial, the other a Multituberculate, both very reptilian in character, and each of about the size of a rat. As this is only a press report, we must wait for technical details, which evidently belong in this place, and would seem to fit in well with what has been already written here.

evidence that during the later part of the Triassic Period there existed in North Carolina several sorts of small animals, varying in size between that of a rat and that of a large mouse; and that in their anatomical structure, or at least in their jaws and teeth, they stood about midway between reptiles and mammals. From the collateral evidence furnished by comparative anatomy and embryology it is fair to assume, although without definite proof, that the body was covered with scales somewhat similar to those found upon the tails of modern rats and mice, and that, as in the latter case, scattered hairs projected from between the scales, and in their arrangement bore a definite relationship to them. It is also probable that these animals laid eggs like those of reptiles, that the young demanded some sort of parental care, and that possibly the young obtained some nutriment by licking the ventral surface of their mother, where certain glands of the integument furnished a slight amount of fluid, primarily intended for the lubrication of the hairs.[1]

25. The next Step: Jurassic Mammals. In a few localities, scattered both geographically and in the age of the deposit, but confined within the limits of the Jurassic Period, are found the fragmentary remains of several related groups of animals that are more definitely mammalian than the foregoing, while at the same time they are far more primitive, and probably more reptilian, than any of the

[1] Aside from *Dromatherium* and *Microconodon*, two other forms, which have sometimes been considered mammalian, must be included among the Triassic remains. One of these is *Tritylodon*, from the Karoo beds of South Africa, the geological horizon of which seems to correspond to the Rhetian, at the very end of the Triassic. This animal, of which nearly a complete skull is known, has long been classed with the Allotheria (§ 26), but recently much doubt has been thrown upon its supposed mammalian affinities, and it is now generally considered to be a reptile. The other is a true Allotherian mammal, *Microlestes*, and its remains consist of a single molar tooth found in the Rhetian deposit near Stuttgart, and two others from a contemporaneous deposit in Somersetshire, England. In spite of the paucity of the remains, the evidence is definite, and *Microlestes* thus becomes the oldest known mammal of the continent of Europe.

mammals of the present day.[1] As in the case of *Dromatherium* and *Microconodon,* they were all small forms and the remains consist mainly of lower jaw halves, although there

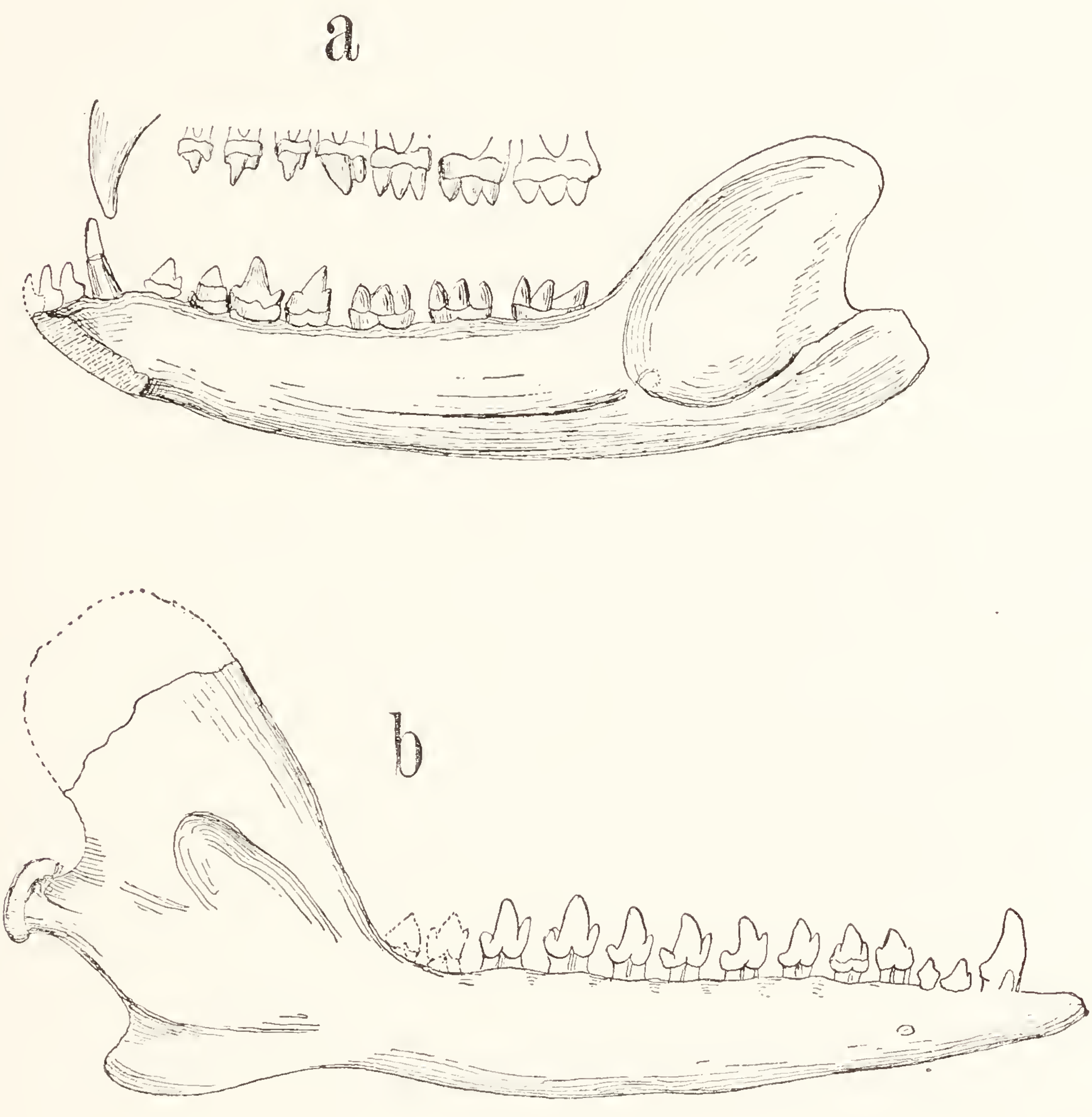

FIG. 21. Mammalian remains from the Upper Jurassic.
a. Triconodon; from the Purbeck beds, England. After Osborn.
b. Diplocynodon; from the Como (*Atlantosaurus*) beds, U. S. From Osborn, after Marsh.

[1] The Jurassic localities which have thus far yielded mammalian fossils are but three in number; the Stonesfield slates and the Purbeck, of England, and the Como or *Atlantosaurus* beds of Wyoming and Colorado. The first belongs to the Bathonian Stage of the Middle Jurassic, the other two, which are about contemporaneous, to the Purbeckian, almost at the very threshold of the Cretaceous. The first furnished the remains of but three Genera, *Amphilestes, Amphitherium,* and *Phascolotherium,* and the second a few more (14 species),

are also a few portions of upper jaws, containing teeth, and a few other bones, which are doubtfully identified as belonging with the jaws.[1]

If a comparison be made between these jaws and those of the Triassic forms, *Dromatherium* and *Microconodon,* it will be seen at once that a long step has been taken in the direction of modern mammals. The condyle is now a distinct, rounded process, and the coronary process is a flat elevated wing, forming a typical ramus, approximately at right angles to the body of the jaw. The groove for the mandibular cartilage is still evident in some specimens, but is by no means as widely open as in *Dromatherium.* In regard to the cheek teeth, that is, the molars and premolars, the process of dividing the root into two fangs, which is barely indicated in the Triassic forms, has become complete, and the parts are as distinct as in the typical mammals of later times. The total number of teeth is, in most of the Jurassic species, still large, but in some cases (ex. *Triconodon*) it is restricted, and approaches certain modern forms.

These Jurassic mammals show, then, in numerous details, a continuation of the same line of development inaugurated by the Triassic forms and continued directly into the mammals of the present day. These jaws strongly suggest, for instance, those of many of the more primitive living mammals, especially the more generalized Insectivora, Carnivora, and Marsupialia; and types can be found among them which seem almost the direct and immediate ancestors of the hedgehog, the dog, and the opossum. Just as

among which are *Triconodon, Amblotherium, Diplocynodon, Spalacotherium, Stylodon,* and *Phascolestes* (=*Dryolestes*). The Como Beds yielded remains very similar to those from the contemporary Purbeck, certain of the genera, indeed, like *Triconodon,* and *Phascolestes,* being identical. In both Purbeck and Como there occur also traces of the Allotheria, the aberrant mammalian branch considered in § 26, e. g., *Plagiaulax* from the Purbeck (the genus "*Bolodon,*" which seems to have been founded upon the upper teeth of *Plagiaulax*); and *Allodon* and *Ctenacodon* from the Como.

[1] For the remains from the Stonesfield Slates cf. Goodrich, in Quart. Journ. Micros. Sci. 1894. pp. 407–432, with excellent figures.

Dromatherium and *Microconodon* indicate almost the point at which the mammalian stem left the reptiles, so these Jurassic mammals suggest a direct continuance by one more step into the mammals of the modern type, both marsupial and placental, and we can well believe that the passage through

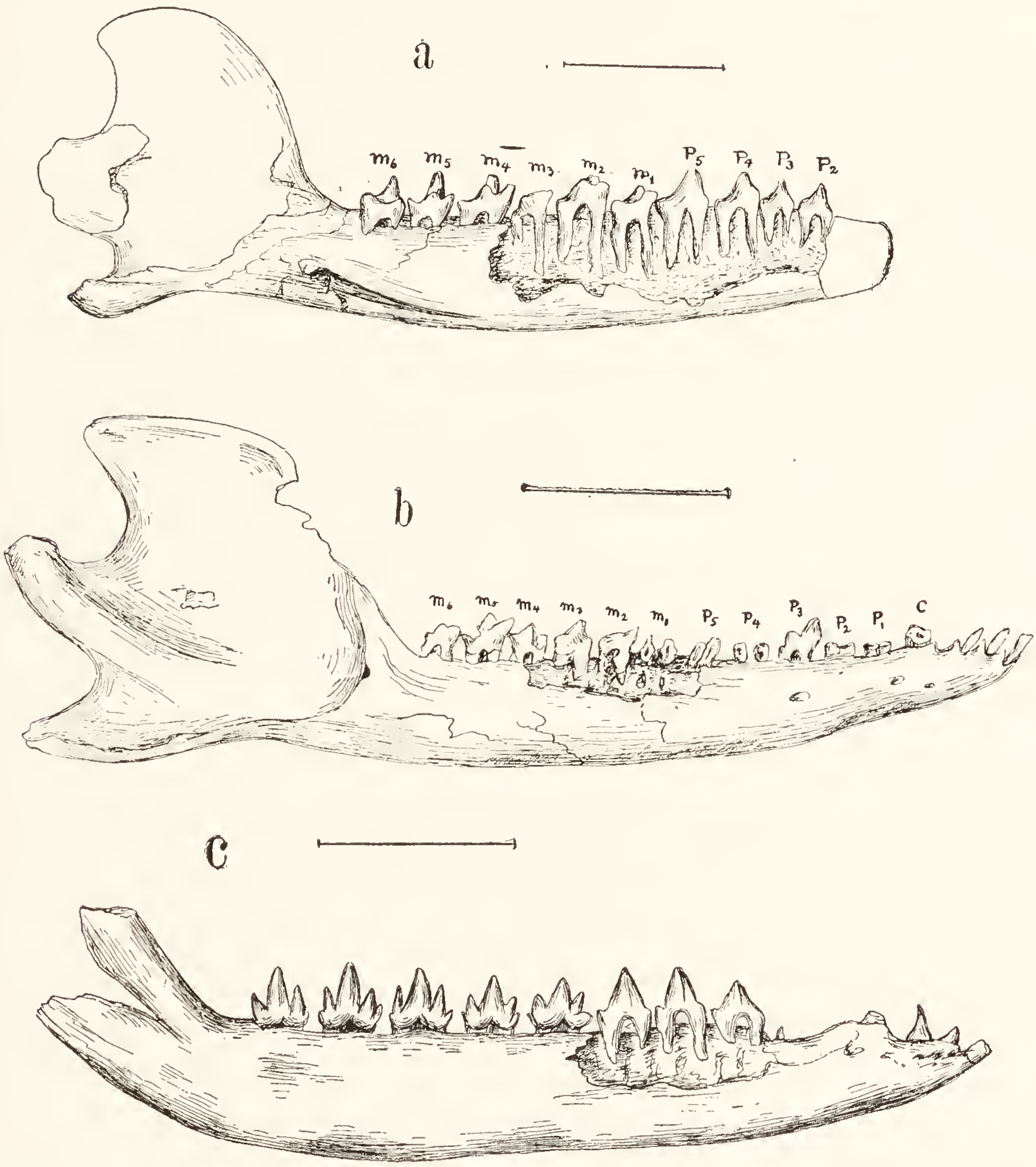

FIG. 22. Mammalian remains from the Stonesfield slates, England; Lower Jurassic. From Goodrich in Quarterly Journal.

a. Amphitherium prevosti; left mandible, inner aspect.

b. Amphitherium oweni; right mandible, outer aspect.

c. Amphilestes broderipi; left mandible, outer aspect (reversed for better comparison with the others).

All of these figures are drawn from the type specimens in Oxford University. The natural size of the specimens is given by the horizontal lines above each specimen.

the Cretaceous developed mammalian forms, that appeared in almost the dress of present-day animals. That this would be seen to be the case if we were in possession of the proper records there is little doubt, but, unfortunately, at just this point there occurs an extensive gap in our collected data, which occupies nearly the entire Cretaceous Period, during which scarce a vestige has been found of any mammal whatsoever. That, in some part of the globe, this evolution did continue, and that it followed practically the lines indicated, becomes apparent from the sudden appearance, in the strata immediately following the Cretaceous, of a large number of typical mammals, the ancestors of the modern lines; and it is to be expected with confidence that at some time, perhaps in the near future, the region in which this development took place may be found and investigated, and that the actual steps in the process will be revealed.

The Jurassic forms show two distinct types of molar teeth, representing distinct stages of development, and indicate, according to some, the beginning of the differentiation of mammals into marsupials and placentals. In the simpler, or triconodont, type the teeth consist of three cusps, which either lie in a straight line, as in *Triconodon* or *Amphilestes*, or show a tendency to fold a little, so that in the mandible, the only part known, the two smaller, or accessory, cusps lie upon the inner, labial, aspect, and the larger, or main, cusp, upon the outer, buccal, aspect (e. g., *Spalacotherium*). In the other, the tuberculo-sectorial type, the lower molars possess, in addition to the three cusps, a backward projecting heel, technically the talonid, as seen in *Amphitherium* and *Diplocynodon*. On the basis of this distinction, Osborn divides these Jurassic mammals into two distinct Orders. The first, in which the teeth are of the simple triconodont type, either straight or bent at an angle, he names the *Triconodonta*, and considers them to be the ancestors of the marsupials (*Didelphia*). The other, in which the teeth have the addition of a talonid, and for which he uses Marsh's

term of *Pantotheria,* he considers the ancestors of the placental mammals (*Monodelphia*). To emphasize this distinction he uses, as alternate names for the two, *Marsupialia primitiva* and *Insectivora primitiva* respectively, the latter in recognition of the fact that the Insectivora are the most primitive group of modern placentals and consequently are the ones nearest these common ancestors of all Placentalia.

As an alternative hypothesis it may be suggested that these various types of teeth represent successive stages in the development of a single line of descent, and that, if we include the Triassic specimens, the following forms make almost a complete series. In *Microconodon* the molars are flat and thin, with about four serrations, which begin with a central one that is taller than the others, and run down in a regular series, the two sides alternating with each other. *Dromatherium* is similar to this, save that here there is a tendency to lose the lowest of the serrations, the one on the posterior or distal aspect, reducing them to three. The next stage is *Amphilestes*, in which, although the fourth and even a fifth serration are represented, the tendency to emphasize the middle three has become more definite; these serrations are also more distinct from each other, and become from now on actual cusps, rather than simple serrations. *Triconodon* is next, in which the three cusps have become definitely established, and the others have disappeared forever; and this is followed by such forms as *Spalacotherium*, in which the three cusps are bent at an angle with each other, so as to form what is technically termed the *trigon* (*trigonid,* in the case of the lower jaws). Lastly come the forms in which has been added a heel, the *talon* (*talonid*) as seen in *Amphitherium* and *Diplocynodon*. From this stage to that represented by the simplest of the placentals, even such living forms as the hedgehog, the transition is obvious.

In this last hypothesis no suggestion is given for a differentiation between marsupials and placentals, but it is by no means certain that at this early time such a differentiation

was indicated. Both marsupials and placentals, as we know them at the present time, are quite specialized types, and it is probable that these Jurassic forms were, strictly speaking, neither. The most primitive marsupials that we know of, the *Didelphydae*, or opossums, do not appear very early in mammalian history (Middle Eocene) and are thus antedated, so far as the records show, by a well differentiated placental fauna. As for the development of the more highly specialized modern marsupials, found today in the Australian world, their appearance there was a very recent event, and took place in the Pleistocene, that is, Quaternary. While the writer may express his opinion that the marsupials are by no means as primitive a group as has been generally supposed, and that, consequently, their origin need not be looked for as far in the past as has been our habit, both this and other surmises on the subject are without a satisfactory foundation in actual data, and we must await the revelations that may come from the future discovery of the Cretaceous record, which is sure to contain the information desired on this part of mammalian history.

26. THE ALLOTHERIA: AN ABERRANT BRANCH OF THE MAMMALIAN STOCK. Contemporaneously with the line of mammalian development sketched above, there existed another branch of animals evidently mammalian, whose history seems to represent an independent line of development. This group, which, in order to emphasize its dissimilarity to all other mammals, was named by Marsh the Allotheria, first appears in strata of the late Triassic (Rhetian); continues throughout the Jurassic, usually associated with the other Jurassic forms; and a few species appear again at the close of the Cretaceous, associated with the remains of the early placentals. This group is characterized especially by its unique type of molar tooth, the approximately flat surface of which is covered with many small tubercles, arranged, sometimes in two, sometimes in three,

longitudinal rows. It is owing to this characteristic that the group received from Cope the name of "Multituberculata."

The oldest trace of these animals is in the form of a single tooth, found in the Rhetian deposit near Stuttgart, and now preserved in the museum at that place. It is termed *Microlestes*, and is the oldest mammalian fragment found in Europe. With this may be placed two upper teeth more recently discovered in a deposit in Somersetshire, and of the same age.

With the beginning of the Jurassic Period numerous representatives of the Allotheria occur, both in Europe and North America. *Ctenacodon*, from the latter continent, possesses four normal premolars, while *Plagiaulax*, from the former, shows an exaggerated fourth premolar, with the other three rudimentary or wanting. Of *Plagiaulax* the entire lower jaw, and a part of the upper one, are known, and occur in the Purbeck deposit of Dorsetshire at the very end of the Jurassic, in association with the jaws of the Triconodonta and Pantotheria. It survived at least into the beginning of the Cretaceous, since a *Plagiaulax* tooth has recently been found in the Wealden deposit of Hastings, a deposit belonging to the Neocomian formation. Technically, then, this little tooth is Cretaceous in date, but it is not only merely upon the threshold of this long period, but is absolutely the only fragment of a Cretaceous mammal thus far known in either continent. At the close of the Cretaceous, however, there is found, in the basal Eocene of both Europe and America (Cernay and Puerco) among a rich mammalian fauna, the remains of a nearly related genus, *Neoplagiaulax*, which seems to show that, in spite of the absence of data, this animal, with but slight modifications, must have been in existence somewhere during the entire Cretaceous Period. In these same deposits of the early Eocene there occur also other typical Allotheria, such as *Liotomus* in the Cernay and *Ptilodus* and *Meniscoessus* in the Puerco.

In general appearance these animals suggest both the

modern rodents, and also certain of the specialized marsupials, like the "kangaroo rats," *Hypsiprymnus* and *Potoroüs*, but this resemblance is only a superficial one, since the form of the molar teeth in all the Allotheria is fundamentally unlike that of any other mammal. The earliest forms, like the Triassic *Microlestes*, had but a few tubercles, arranged in two rows, but the later forms increased the number of

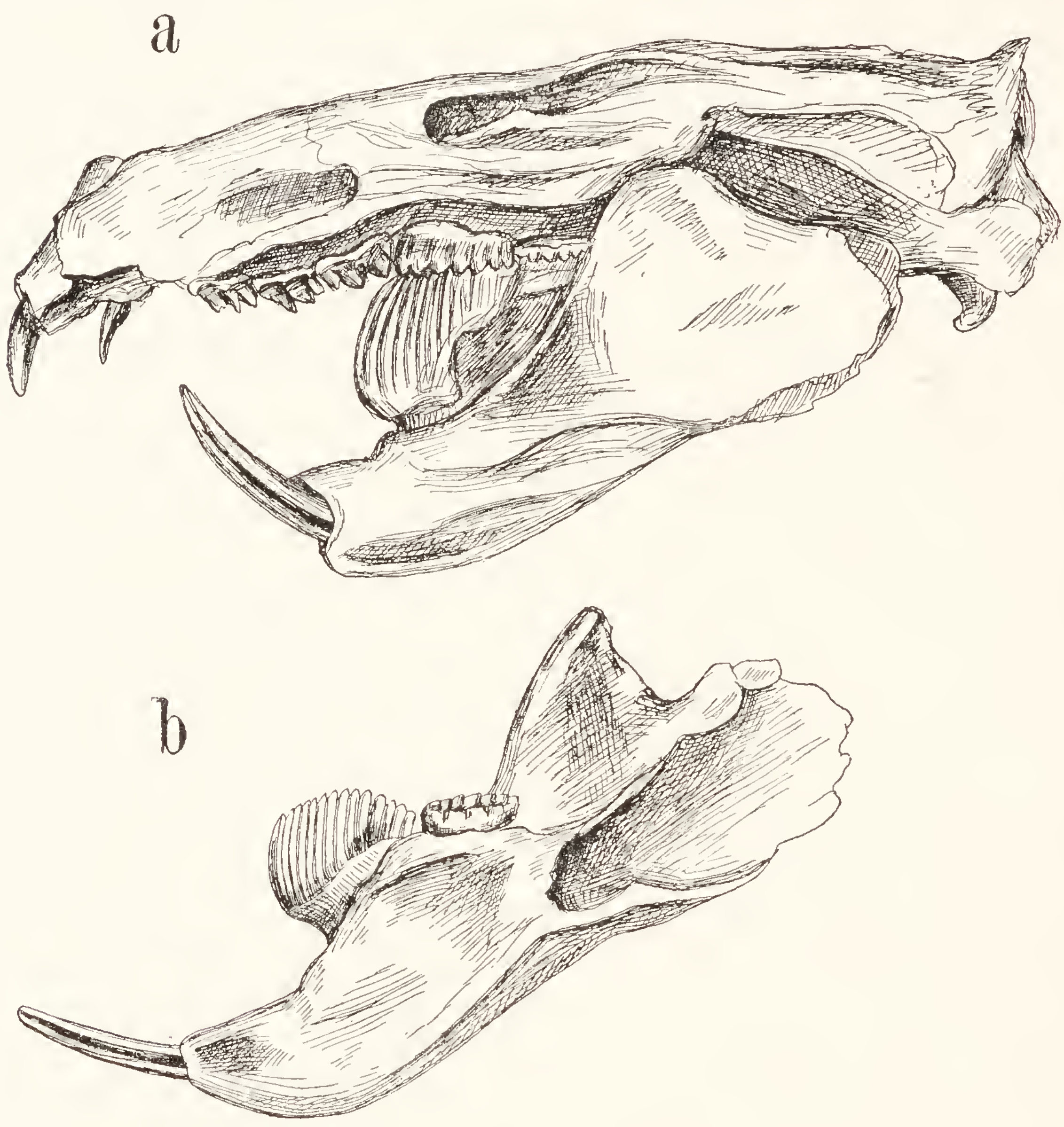

FIG. 23. An Eocene (Puerco) Allotherian, *Ptilodus gracilis*. After Gidley.
a. Skull, profile.
b. Mandible.

tubercles and had three rows of them; in other words, the course of development of the molars was from *paucituberculate* to *multituberculate*. Another important feature is the sharp edge upon the premolars, which is often armed with numerous fine serrations. In *Plagiaulax*, *Meniscoëssus* and *Ptilodus* one premolar, the fourth, is especially

developed; this is grooved, corresponding to the serrations and forms a conspicuous feature in the jaw. (Fig. 23.)

Beyond the Eocene the paleontological history of the Allotheria cannot yet be followed, but there is a small group of living mammals, the Monotremata, which show some cause for being considered a related stock, if not actual descendants. As adults each of the two living

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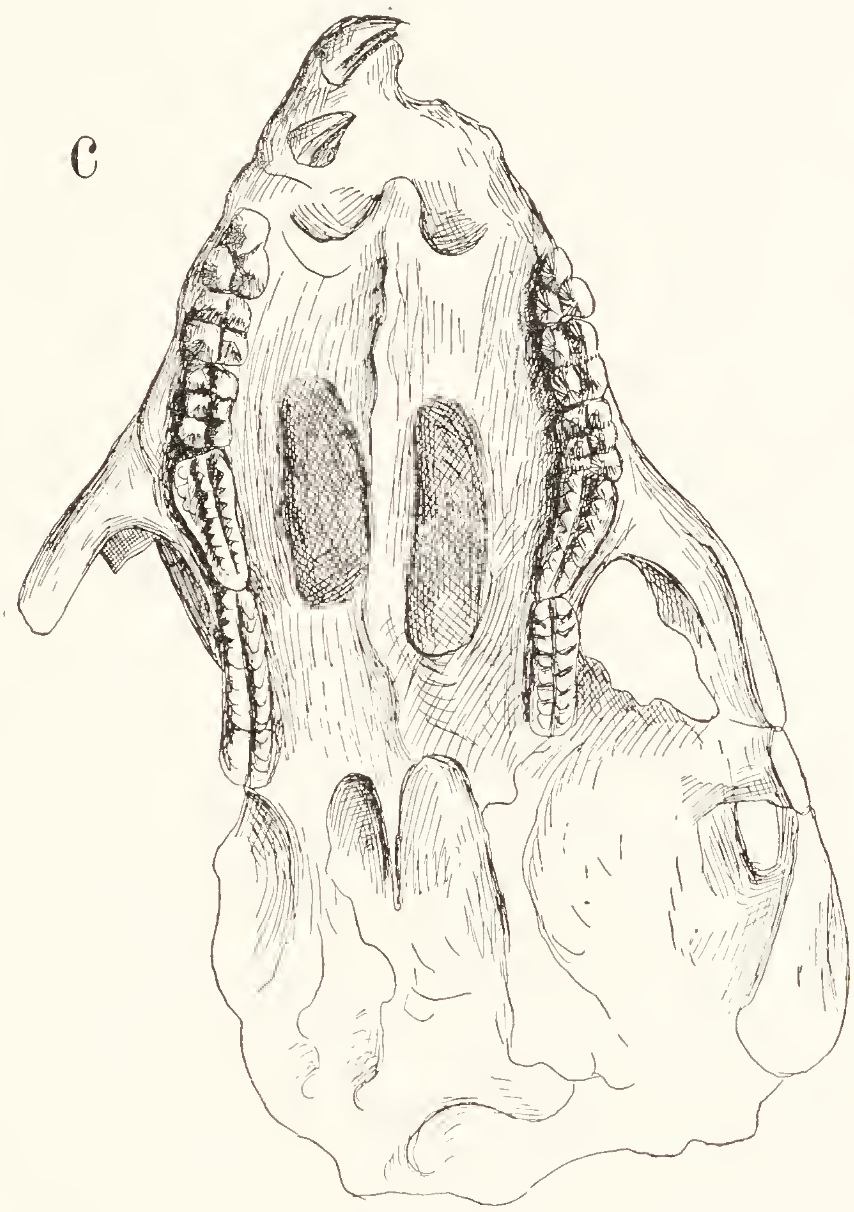

Fig. 23 (Continued). *c.* Skull, from beneath.

species, *Ornithorhynchus* and *Echidna*, are toothless, but in the jaws of the young of the first-named there develop temporary teeth that somewhat resemble poorly formed teeth of the multitubercular type, especially those of *Microlestes*. This supposititious relationship, even though corroborated, will not assist in explaining the relationship

of this group to other mammals, for the monotremes are quite as distinct from other forms as are the Allotheria, and even the knowledge of the soft parts and of the embryology, which in these modern forms is, of course, available, does not show any point of direct contact between this aberrant stock and the other mammals.

The entire history of the Allotheria, then, even including the monotremes, is one of a specialized line of mammals which early[1] departed from the main line, perhaps when this was still almost as much reptilian as mammalian; and although never very abundant in species, it has maintained its existence during the enormously long period from the Triassic to the present time, an existence that begins with *Microlestes* and ends with *Ornithorhynchus*. The problem of the phylogeny of the other mammals, and the mutual interrelationships of the various forms, is rendered much simpler, particularly during the still somewhat obscure early history, by the removal of this aberrant branch from the rest.

27. THE SILENCE OF THE CRETACEOUS. To the Jurassic Period there succeeded immediately the Cretaceous, a long interval of time which, more than any other, marks the transition from the archaic to the modern world. Throughout the Jurassic the flora presented a strange appearance, with forests of ferns and cycads, overgrown club-mosses, and huge *Equisetae*, mixed, towards the end of the Period, with evergreen trees, like pines and firs, together with related forms with flat fan-shaped leaves, like the gingko (*Salisburia*). Almost at the beginning of the Cretaceous, however, there were added to these gymnosperms, the advance guard of our modern flora, the great army of hardwood trees; and as these advanced, the more ancient forms of vegetation retreated, and gymnosperms and angiosperms replaced the great cryptogams.

The angiosperms, so characteristic of modern times

[1] Triassic, or, more probably, pre-Triassic.

everywhere, seem to have appeared simultaneously and quite suddenly in both Europe and North America, and in such a form that we may conclude that they came as the result of a migration from elsewhere rather than that of a development on the spot. Their appearance is practically contemporaneous with the beginning of the Cretaceous, for a few stragglers, quite unlike any living forms, but still evidently angiosperms, are found in such deposits as the Cercal of Portugal and the Potomac, both usually estimated as basal Cretaceous, or Neocomian. These forms appear to have been the ancestral representatives of several widely differentiated modern Orders, such as the myrtles, the viburnums, the figs, the poplars and willows, while a few suggest the monocotyledons. Some of them appear to be neither mono- nor di-cotyledons, but ancestral to both, the "pro-angiosperms."

Passing up through the Cretaceous, both branches of the angiosperms, the mono- and di-cotyledons, rapidly assume the modern variety of forms, too rapidly, in fact, to be the result of development in place; and in the Cenomanian stage of the Neo-Cretaceous, from which strata an abundance of forms has been studied, the flora is essentially modern. In Europe and North America a mild and equable, though semi-tropical, climate seems to have prevailed. The highlands were covered with forests in which, among pines, firs, cypresses, and cycads were to be found oaks, chestnuts, poplars and willows. Numerous species of sassafras, a tree now confined to the Western Hemisphere, were then spread over both continents, together with the tulip-tree (*Liriodendron*); and the warmth of the climate was everywhere marked by figs, magnolias, plane-trees, laurels, and myrtles, as well as by palms and bamboos, which then first made their appearance, and testified to the high development of the monocotyledons. A plentiful undergrowth of low bushes and herbaceous plants, largely of the pea and rose Families, was present, and trailing vines of various kinds, the ivy,

the bittersweet, and the grape, clothed the rocks and hung in festoons from the trees. The plains were covered with sedges and grasses, or at least grass-like plants, and the wetter places furnished a store of rushes and other aquatics.[1]

But not the flora alone gave the two continents under consideration the appearance of the modern world. Hosts of insects, representatives of all the modern Orders, swarmed over the vegetation; insects of a high degree of differentiation. The flowers were frequented by bees and butterflies; the vegetation was attacked by leaf-eating and boring beetles; even predaceous and carnivorous insects, mostly flies and beetles, were not wanting, either preying upon each other or hovering as external parasites about the larger terrestrial animals. These latter were well represented by the reptiles, which were still very numerous and often of huge proportions, and by birds, which except for the persistence of teeth, show few traces of their reptilian ancestry. Yet in a landscape so modern and varied, there seems to have been one important lack. In all the formations from the Neocomian to the Cenomanian, and far beyond, to the very end of the Cretaceous, not a single mammalian fragment is known. This may in part be due to the lack of good fortune in finding the remains,[2] but since mammalian

[1] As the science of Paleobotany is now far advanced it possesses an extensive bibliography. The following titles represent a few important and easily accessible papers on the subject, and may serve as an introduction to the subject:—

Ward, Lester F. Some analogies in the Lower Cretaceous of Europe and America. 16th Ann. Rep. U. S. Geol. Survey; 1894–95, pp. 463–543.

Ibid. Article "Fossil Plants" in Johnson's Universal Cyclopedia.

Gardner, J. S. Articles in *Nature* for 1877 and 1878; also on fossil grasses and their importance in the development of the large herbivores in Proc. Geol. Assn. 1885–1886.

Cockerill, T. D. A. The Miocene trees of the Rocky Mountains, Amer. Nat. Jan. 1910.

Newberry, J. S., and Hollick, A. The later extinct Floras of North America. U. S. Geol. Survey, 1898.

[2] The argument that mammals may have occurred in Europe and North America throughout the Cretaceous, and may even have been fairly abundant, but that their remains have not yet been found, gains considerable support

remains are extremely abundant from the time they reappear to the present; and since otherwise the fossils of the Cretaceous are so well-known; we are led to believe that during this enormous space of time the mammalian fauna in the regions thus far investigated, mainly Europe and North America, was extremely scanty. We may safely assume, however, the continual presence in these regions of certain of the

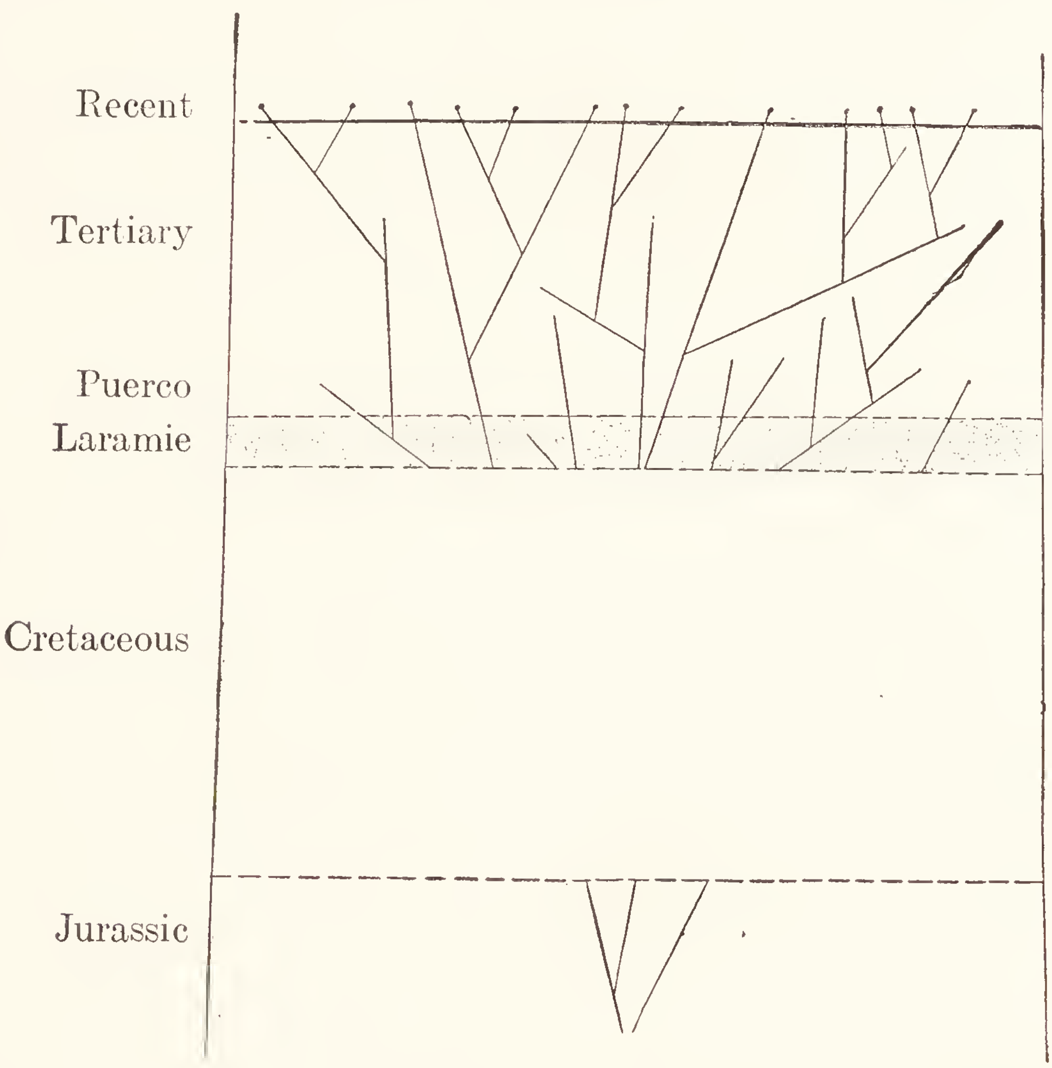

FIG. 24. Diagram illustrating the effect upon our knowledge of an animal group of the complete loss of the records during a long period. The case in point here is that of the complete absence of the remains of Eutherian mammals during the entire Cretaceous period, except at the very end.

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from the fact that the earlier remains, although often including the records of numerous species, occur in very small deposits, and have been largely discovered by chance. Thus the entire deposit of the Purbeck, in which were found the remains of 14 species of mammals, was a thin layer of not more than a few centimeters in thickness, and covered over an area of about 500 square meters, that is, about 65 feet square. If this small bed had not been found there would have been no record in Europe of the occurrence of mammals in the Upper Jurassic.

Allotheria, since remains of these animals occur upon both sides of this lost interval (Purbeck and Laramie), and since the differences between the pre- and post-Cretaceous specimens are inconsiderable. If, however, we accept the probable relationship of this group to the present-day Monotremes, the entire group represents a very divergent side-branch, and does not help in the question of the history of typical mammals. Of these latter the record ends with the forms of the Purbeck and Como (*Atlantosaurus*) beds, at the time at which these typically Jurassic forms were beginning to show a differentiation that may indicate the two great wings of the Eutherian Mammals, marsupials and placentals; but before this suggestion passes the realm of surmise, the curtain drops, and we have no further information concerning the history of mammals, until with the end of the Cretaceous and the beginning of the Eocene, they again invade the territory in question in many well-differentiated forms, the ancestors of most of our modern Orders. Where they developed and along what lines; whether the Upper Jurassic Triconodonta were really the ancestors of the marsupials and the forms with the more extended molars the ancestors of the placentals; all these and other such questions must wait for later discoveries to explain. All we can say positively at present is that the record of primitive mammals ends abruptly with the end of the Jurassic, and that when, after the silence of the Cretaceous, the story of the mammals is resumed, it deals with a numerous array of typical placental forms, among which are living a few Allotheria.[1]

[1] We cannot conclude, as formerly taught, that the Jurassic mammals were either themselves marsupial, or that they gave rise directly and immediately to marsupials. The first definite marsupial remains known, if we except the doubtful remains of such forms as *Didelphops*, *Cimolestes*, etc., from the Laramie, are those of the genus *Peratherium*, closely allied to *Didelphys*, the opossums, the most primitive modern marsupials, and these are mid-Eocene or later, much too late to be the direct descendants of the Jurassic forms. Perhaps the soundest hypothesis, in accordance with our present knowledge on the subject, is that of Osborn, who sees in the latest Jurassic remains the

28. The Resumption of the Record: the Laramie Formation. Thus, with the coming of the Cretaceous, the curtain shuts down upon mammalian history and so remains until its very end. The last glimpse obtained is that of the Purbeck and Como beds of the Upper Jurassic, in which are represented the two groups of Triconodonta and Pantotheria, the first with typical three-cusped molars, the second with molars to which a heel or talon has been added. These two groups seem to some to represent the beginnings of the two great Eutherian divisions, marsupials and placentals, but whether they do or do not cannot be positively decided, for here the record comes to an abrupt end, not to be resumed until the very end of the Cretaceous. During this long interval of time many of the records of development along other lines are well known. The great reptiles, at their height during the first part of the Period, at the end are on the wane; the first bird-like form of the Jurassic, the *Archeopteryx*, has become replaced by genuine birds, much like modern forms save for the rows of pointed conical teeth in the jaws; hardwood trees, as well as forests of palms and bamboos, have gained the ascendency over the tree ferns, the cycads, and the gigantic club-mosses; while the plains are becoming clothed with rush and sedge-like vegetation, and perhaps by true grasses; yet in all these scenes, apparently now so well fitted for their presence, mammals seem to be wanting. In North America, from the Como to the Laramie deposits, an interval spanning practically the entire Cretaceous, not a mammalian fragment has ever been identified, and in the corresponding deposits of Europe the condition is the same. Indeed it is in America that the record is first resumed, for the Laramie, in which mammals are next met with, is placed at the very end of the

tendency to differentiate into both marsupials and placentals. Whether this be accepted or not, it would seem that the marsupials as we know them could not have been the ancestors of the placentals, and that the mammals of the lost intervals were the transition forms between the Jurassic types and true the placentals, types like primitive Insectivora.

Cretaceous, while in Europe the next mammal-bearing deposit after the Purbeck is the Cernay, of the Thanetian stage, and therefore Eocene, corresponding to the American Torrejon. The Laramie fragments, few and incomplete, are mostly Allotherian, and show little change from those with which the mammalian record ended at the beginning of the Cretaceous; but among them are a few traces of genuine Eutherian mammals, the earliest known.[1] So far as can be made

[1] In 1882 E. D. Cope made the first mention of mammals from the Laramie in a short note of two pages, without figures (Amer. Nat. Oct. 1882, pp. 830, 831). In this he announced the discovery of the fragments of two species, of which only one, consisting of two molar teeth and the fragment of a humerus, was sufficiently definite to receive a name. To this he gave the name of *Meniscoessus conquistus* (gen. et. sp. nov.) This little animal "was about the size of the Australian bandicoot and was probably a true marsupial." (Cope.) The first figure of *Meniscoessus*, a poor one, appeared in 1884 (Amer. Nat.) in an article by the same author upon "The Tertiary Marsupialia," mainly Allotheria, which covered the whole Tertiary period, and did not emphasize the Laramie fragments. Thus it was that, five years after this, O. C. Marsh announced in two successive articles the "Discovery of Cretaceous Mammalia" (Amer. Journ. Sci. Ser. 3. Vol. XXXVIII, pp. 81-92, and 177-180). These, like *Meniscoessus*, were from the Laramie, and seem to have been only Allotheria, with no indication of a true Eutherian; and the same is true of a large number of fragments which came to light later and were figured by the same author (Amer. Journ. Sci. Ser. 3. Vol. XLIII, pp. 249-261). Although at the time much confusion reigned from the fact that both Cope and Marsh thought that they had to deal mainly with marsupials, it has since become clear that such was not the case, and that the remains proved merely that Allotherians existed in North America at the end of the Cretaceous, a conclusion also to be drawn from the close similarity of such animals as *Plagiaulax* and *Neoplagiaulax*, at the two ends of the period. An interesting phase of the discussion was that of the strong criticism of Marsh's work by Osborn, and Marsh's reply, summarized in two articles in the American Naturalist (1891, 595-610, Osborn, and 611-616, Marsh). In his criticism Osborn accepted a few of Marsh's species, allowing a few of them to be Trituberculates, but showed that for the most part he constructed his species out of the fragments of a few Allotherians. "The large Cretaceous fauna described by the writer is therefore seen to be principally composed of synonyms." Thus, summarizing the results we find first that these Cretaceous mammals occur at the very end of the period, the Laramie; second, that nearly all of the species are Allotheria; and third, that, although there are some four species that are trituberculate, and hence not Allotheria, these are very primitive and belong, therefore, rather in the group with the mammals of the Jurassic than with the typical Eutheria of the later times.

out, these not only suggest marsupials and insectivores, as was to be expected from the Jurassic division into Triconodonta and Pantotheria, but also very primitive carnivores and ungulates, some of which are yet, in a way, highly specialized; too much so in fact to be considered either as members of the existing Orders or as their direct ancestors.[1] In fact, this high specialization, together with the absence of forms of a more generalized type, lead to the conclusion that these Laramie Eutherians were not developed in place, but invaded the territory in which they are now found from an unknown region, in which they originated. It may not be too fanciful to think that it was in this unknown locality that the Jurassic Triconodonta and Pantotheria having within them the possibilities of, respectively, marsupial and placental Eutherians, withdrew at the beginning of the Cretaceous; that there they had been developing along the lines suggested when last seen, and that finally the specialized descendants reappeared in their ancestral territories by means of migration. This assumption explains also the repeated phenomena of the equally sudden appearance of other new mammalian faunae in each of the succeeding stages: the Puerco, the Torrejon, the Bridger, and so on; faunae unlike each other, and not to be directly derived from each other, which continue to appear at intervals throughout the Tertiary.

29. The Successive Eutherian Invasions. These successive invasions, as they may be considered, of distinct faunae of Eutherian mammals, mainly placentals, form a unique feature of the Tertiary, and are to be explained only on the basis of some sort of assumption like the one just presented, that of successive migrations. Thus the Laramie invasion, the first of the series, was followed in North America by the successive faunae of the Puerco-Torrejon, the

[1] Osborn, H. F. Fossil Mammals of the upper Cretaceous beds. Bull. Amer. Mus. Nat. Hist. Vol. V. 1893. pp. 311–330.

Wasatch, the Bridger, and so on; and in Europe by stages of corresponding age. Furthermore, the contemporaneous faunae of the two continents at each stage show a remarkable degree of similarity, often that of pairs of closely allied genera, the one in Europe, the other in North America. This continually occurring phenomenon, together with the distinctness of each of the successive faunae from the preceding, not only suggest the sudden introduction of each fauna through migration, as has been previously stated, but renders it necessary that the land of origin of these faunae was about equally distant from each of the two continents involved.[1]

The great Puerco-Torrejon migration of the early Eocene brought into America numerous important mammals. For the first time appeared the Creodonta, the ancestors of the Carnivora, and the final development of the one into the other, from the time of the first appearance of the stock, was enacted in the new land; there appeared also the Condylarthra, originally near relatives of the Creodonta, but destined to diverge and produce the numerous groups of ungulates. There were representatives of the Orders Taeniodonta and Amblypoda, the first related to the edentates, the second to the ungulates, and neither of them destined to survive to modern times. The Allotheria were also largely represented, but it is their last known appearance, although, if we see in the modern Montremes their modified descendants, which is probable, some representatives of the group must have lingered on inconspicuously during the long intervening interval. Of the Puerco fauna, while the majority of the mammals were still of moderate proportions, some

[1] The probable successive migrations, with the faunae introduced by each, have been carefully outlined by the French paleontologist, Charles Déperet. His conclusions, revised to Nov. 1907, and translated into English, have been published under the direction of H. F. Osborn, and are found in the American Naturalist for 1908 (several parts). Consult also Osborn, in Annals N. Y. Acad. Sci., July 1900; and Osborn and Matthew in U. S. Geol. Survey, 1909, Bull. 361.

were already assuming the size of the larger forms of the present time, while in the strata of the associated Torrejon, a later period during the same immigration movement, the size was still farther increased.[1]

The European Cernay formation corresponds to the Torrejon of North America both in point of time and in the similarity of its fauna. Two families of the Creodonta, Arctocyonidae and Mesonychidae, and one family of the Allotheria, the Plagiaulicidae, are found in both, although, as usual, with generic differences between the representative in the two continents. Lastly, in the American strata there are two genera, *Indrodon* and *Mixodectes*, which have been considered Primates by some investigators, but this is by no means certain. It may, however, be pointed out that at their origin the Creodonts, Primates and Insectivores must have been closely related, and that before there was sufficient differentiation to establish these lines definitely as distinct Orders, such doubtful forms are to be expected.

The next invasion, represented in America by the Wasatch deposits, and corresponding to the European Sparnatian and Ypresian, is rendered noteworthy by the first appearance of certain modern Orders, including the Rodentia, Artiodactyla, and Perissodactyla, as well as typical Primates. The most of the groups introduced during the preceding migration are still present, and their slight modifications show that they are now progressing by a normal development in their adopted country. In this period the correspondences between Europe and North America are not so striking, but they are alike in the simultaneous appearance of the same modern Orders, each already quite specialized. The rodents are mostly Sciuridae or squirrels; while the Primates,

[1]For descriptions of the mammals of the various Eocene Series cf. Leidy, Report U. S. Geol. Survey, 1873, Vol. I, No. 1; also several papers in Journ. Acad. Nat. Sci. Phila.; Cope (Puerco), Trans. Amer. Philos. Soc., Vol. XVI. 1888; Osborn and Earle (Puerco), Bull. Amer. Mus. Nat. Hist. VII. 1. 1895; (Uinta) Osborn, in same periodical, VII. 2. 1895. For the Uinta cf. also several papers by Scott and Osborn in Trans. Amer. Philos. Soc. 1890.

small and lemur-like, are as fully adapted to an arboreal life as at the present day.[1]

The subsequent history of the Tertiary mammals is a further illustration of the same phenomenon; successive invasions of new forms, the gradual development of forms once introduced, and the later extinction of some and the perfection of others. Sometimes an animal, or an entire group, becomes extinct in one continent while it lives on in the other, either for a definite period or up to the present time. As a case in point may be cited the Primates, which appear simultaneously in the early Eocene of both continents (Wasatch, Sparnatian), but disappear from North America with the close of the Bridger, while in Europe they are continued to nearly the close of the Tertiary; perhaps even to the advent of Man.

30. Theoretical Completion of the Fragmentary History of Mammals. It must be admitted, after a survey of the portions of early mammalian history known, that, however suggestive are the facts thus far presented by actual remains, the record is still a very fragmentary one, and that in several places there are important gaps to be filled up by collateral evidence and by logical deductions. Of collateral evidence the most important has been that afforded by the study of paleobotany which, through ascertaining the constituents of the flora at the different stages, enables us to determine with considerable accuracy the climatic conditions prevailing at each stage and in each locality. A second line of evidence is the determination of the probable configuration of the continental areas at the various epochs, in establishing which the data obtained from other sources must be in harmony with the theories concerning the time and the direction of the migrations.

We may begin, then, with the assumption of a continual series of slow changes in the land and water areas of the

[1] Cf. Osborn and Wortman, in Bull. Amer. Mus. Nat. Hist., IV, 11. 1892.

globe, changes considerable enough to have fundamentally altered not once, but many times, the relative communications between the several continents, as well as to have modified the shape and extent of the continents themselves. To this we may add an equally continual series of climatic changes, affecting entire continents, or even hemispheres, although such changes must have been very gradual. In this latter assumption is suggested a possible reason for certain of the migrations, although the climate probably acts indirectly on the animals, through effecting changes in their associated plants; since the latter are more directly susceptible to such influences, while the former usually possess much power of acclimatization, provided a climatic change is sufficiently gradual.

At the beginning of the Cretaceous Period the climate of the entire Northern Hemisphere, even including the polar regions, was much like that of the tropics today. Such extreme northern localities as Greenland and Spitzbergen were covered with forests of cycads and tree-ferns, certain of the latter consisting of genera now found only within the Torrid Zone. The plants of these regions corresponded to those of modern times which are associated with a mean annual temperature of 72-74° F.; farther south, at the latitude of 40-50° N., the climate must have been still more tropical.

By the commencement of the Eocene there were perceptible the indications of a slight cooling, especially marked in the more northern regions; although even here the temperature was at least warm temperate, while in Europe and in the territory of the United States it was tropical. This change, though definite, must still have been extremely slow, since in the Lower Miocene of Spitzbergen, at a latitude of 78-79° N., the forests consisted of such trees as magnolias, chestnuts, and sassafras, although the cycads had disappeared. In this country there grew the swamp cypress (*Taxodium distichum*), now living in our southern states.

Similar remains of the same period, indicative of a warm temperate climate, are found in Grinnell Land at but eight and one-fourth degrees from the pole.

When, finally, the cold began to prevail, its approach became much more rapid, beginning, as always, at the north, and continued until the end of the Tertiary, when it culminated in the great Ice Epoch. A northern cap of ice extended southward to the latitude of about 50° N. in the Eastern Hemisphere, and ten degrees lower in the eastern portion of the Western. After several retreats and advances, alternately uncovering and concealing again an extent of ten to twenty degrees of latitude, and producing several interglacial periods, the ice began its final retreat, a movement which is still going on. With the exception of the glacial remnants still left upon the tops of the higher mountains, as in Switzerland, the edge of the ice is now well within the polar circle, still including within its sway Greenland and Spitzbergen, once the home of a tropical vegetation.

This remarkable condition of the climate during the early phases of mammalian history, as deduced by the paleobotanists, suggests a plausible supposition concerning the location of the original center where the initial development of the Eutherian mammals took place and from which issued the successive migrations that spread over the continents of North America and Europe; in short, the north polar regions. The establishment of this region as an active theater of development during the Cretaceous and Tertiary will account for the repeated simultaneous appearance of so many successive faunal and floral waves over the two regions mentioned, since the pole is about equally distant from both. From this center the first of the Eutherians, the ancestral carnivores and hoofed animals, may have wandered southward during the Laramie; and here they remained and developed, joined from time to time by other migrants. Squirrels came in the Wasatch, and Primates in the Bridger, not unformed and scarcely differentiated,

but full-fledged and specialized; migrants from the same land of origin from which the Laramie animals had previously come, and from which, long before, had spread the life which clothed these newly possessed lands with hardwood forests, with palms and bamboos.

If all this be so, as seems at present an unavoidable conclusion, the strata of these ice-covered lands must hold the records of the origin of Eutherian mammals in general, as well as those of the various modern Orders which have appeared one after another in the regions thus far explored. Certain of the deposits, even here, have been investigated to some extent, and have yielded important contributions to fossil botany, as has been seen. Surely it is not too much to hope that similar discoveries in the history of mammals, perhaps the entire lost Cretaceous record, may be yet unearthed, and this, and only this, will enable the hypothesis of the polar origin of Eutherian mammals to be tested. Until this is done this portion of the history of Man's origin must remain incomplete.

A modification of this theory of the polar origin of the Eutherian invasions consists in the assumption that a part of these sudden appearances may have been due to migrations back and forth among the known continents, while still retaining a belief in the northern regions, or some other unknown locality as the source of the remainder. Such a modification is quite acceptable, as it is not only more in accordance with probability than that which considers that all the developmental history took place in a single center, but is also supported by the assumption, made in accordance with independent facts, that, during the time in question, the continents were not related as at present, but that, for example, during the Cretaceous, and for a long period previously, South America and Africa formed parts of a single continent, while during the entire Tertiary there was a considerable land bridge between North America and Europe. From the Miocene on, or from an earlier period,

Africa and Europe were probably connected through a series of land bridges, running north and south, and now indicated by the peninsulas and chains of islands running across the Mediterranean. By the assumption of these geographical conditions repeated intercontinental migrations become almost a necessity.[1]

In this way Deperet explains the Creodonts of Cernay (Thanetian); the Primates of the Upper Ypresian and Lutetian, and the opossums of the Ludian, as immigrants from North America; but he attributes the successive appearances of the different rodent families of the Upper Ypresian, Lutetian, Ludian, and so on, to a series of migrations from an unknown source. From the middle Oligocene on he finds a series of migrations from Africa to Europe; and to this source he traces the successive appearance of anthropoids, beginning with the lower Miocene (Burdigalian). In the estimation of others, Ameghino for example, South America has played a most important role as a center of origin of various mammals, notably Primates, although such an assumption is quite revolutionary and necessitates some modification of the most widely accepted views concerning the continental relations during the period involved.

31. The Earliest Known Primates. In the successive invasions of Eutherian mammals over the continents of North America and Europe the Primates were among the first comers. In the Puerco-Torrejon appeared two genera, *Indrodon* and *Mixodectes,* which seem to show some Primate affinities,[2] and in the Wasatch, Wind River and Bridger

[1] For speculations concerning the continental relations of the Tertiary cf. Matthew, Hypothetical Outlines of the Continents in Tertiary Times, Bull. Amer. Mus. Nat. Hist. XXII. 21. Oct. 1906. Certain literature on paleobotany has been already cited under § 27.

[2] A specimen in the American Museum at New York (No. 833), which consists of the fragments of several limb bones, presumably of one individual, show numerous Primate characters, and if it prove a true Primate, it is the most primitive known. It is from the Torrejon, and was long associated with *Indrodon* through error. (Osborn; Amer. Eoc. Prim.; Bull. Amer. Mus. Nat. Hist. 1902.)

deposits of North America, and in the contemporary Ypresian and Lutetian of Europe, there appear several typical Primates, which, although possessed of numerous generalized characters, are decidedly anthropoid in appearance, and may represent the earliest glimpse of the history of that Sub-Order.

Among the North American forms of this early epoch there are represented three genera, *Pelycodus*, *Notharctus*, and *Tetonius* (*Anaptomorphus*), each with several species.[1] These may be taken to represent as many stages in development, in the order named. The most generalized is *Pelycodus*, an animal of about the size of a small rabbit. The head had a long facial portion, about as in an opossum, and the two halves of the lower jaw were separate, as in most mammals other than Primates. The dentition, of which the formula is $i\frac{2}{2}\text{-}c\frac{1}{1}\text{-}pm\frac{4}{4}\text{-}m\frac{3}{3}$, is Primate in character, and the molars are much as in *Notharctus*. If we may rely on the identification with this species of certain other skeletal parts found by Cope in association with the jaws, one at least of the digits ended in a claw.

Notharctus is a little later in its appearance than *Pelycodus*, being identified with the Wind River stage, rather than the Wasatch, and correspondingly shows some advance upon its predecessor. Its many species, which are abundant from the time of its appearance throughout the Bridger formation, are more monkey-like in general form than the previous genus. The average size of its species may be compared, as was done by Cope, to the modern "capuchin" monkey, *Cebus capuchinus*. In the shape of the face *Notharctus* shows some recession of the snout when compared with *Pelycodus*. The two halves of the lower

[1] Aside from the three typical genera given here the North American deposits have yielded fragments of numerous other associated genera. The genera *Omomys*, *Hemiacodon*, and probably *Euryacodon*, possessed three premolars and seem allied to *Notharctus*; while *Washakius*, and perhaps *Microchoerus*, belong with *Tetonius*.

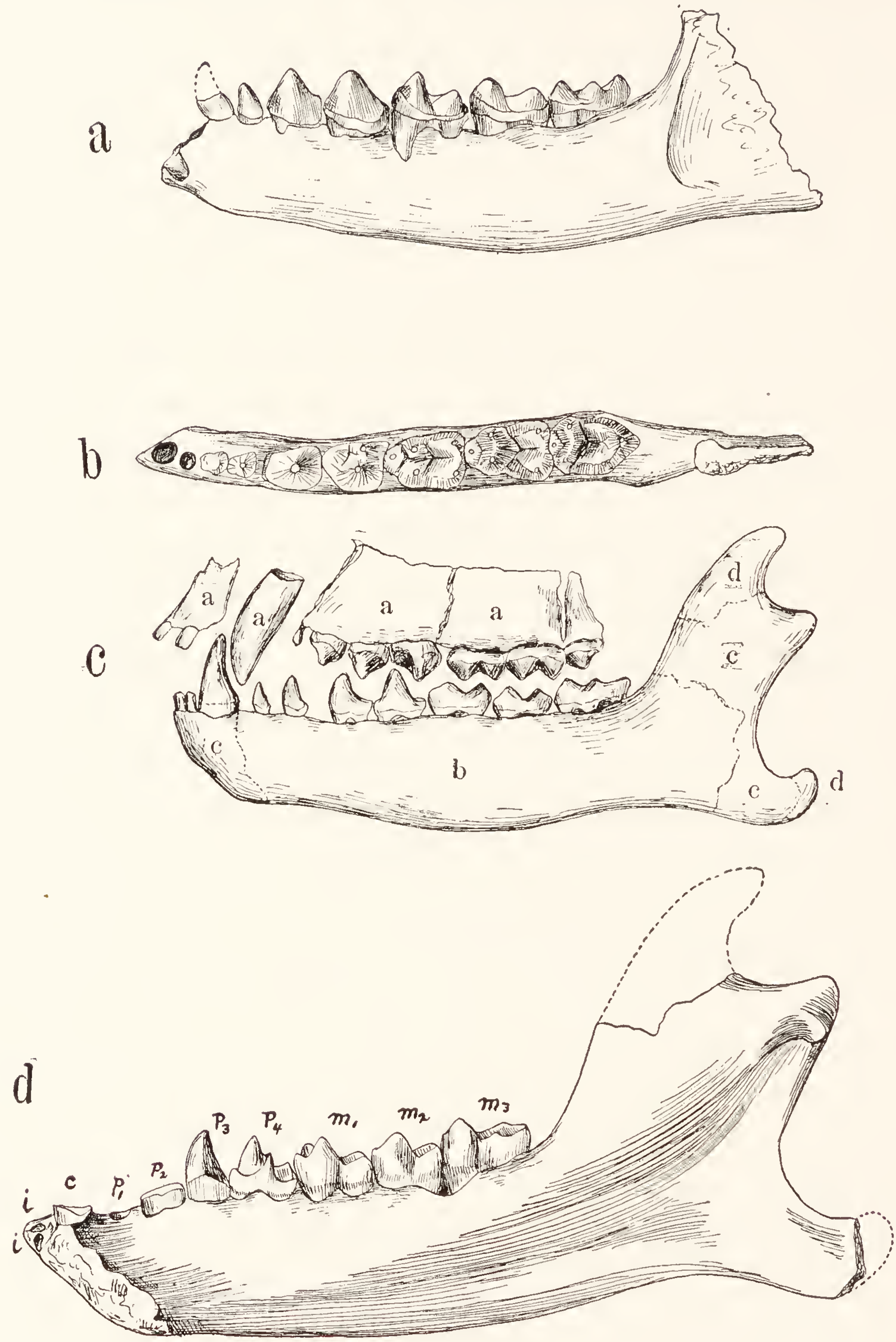


FIG. 25. Remains of the oldest mammals with Primate affinities.

a and *b*. *Hemiacodon gracilis*, Marsh. After Wortman.

c. *Pelycodus*, composite drawing from fragments of several species, as given by Cope and Osborn. In the figure the pieces marked *a* are from *P. tutus*, in Cope s Tert. Vert.; the piece marked *b* is from the same species, after Osborn; the two pieces marked *c* are from *P. frugivorus*, as given by Osborn, and the two pieces marked *d* are obviously restorations, but with no doubts as to their certainty.

d. *Pelycodus frugivorus*, from Cope after Osborn.

jaw are fused, and the antero-posterior breadth across the symphysis is considerable, two definite Primate characters. Otherwise the two genera show many points of resemblance, and are at present placed in a single family, the *Notharctidae*.

The third of the series, *Tetonius* (*Anaptomorphus*), is quite distinct from the two preceding, and belongs in a family of its own, the *Anaptomorphidae*. Its general appearance may be easily concluded from the figure (Fig. 26a), a composite drawing made by Osborn and Matthew from numerous specimens. It is much smaller than the others, being no larger than a rat or a red squirrel, or better a small lemur; its chief characters are so salient that they may be perceived at a glance. The snout is as much reduced as in most modern anthropoids; the orbit of the eye is enormous, and the orbito-temporal partition is evidently complete. The molars are three in each jaw, the premolars are two in the upper and three in the lower, and there is a canine in each. The incisors are not known. In all these peculiarities *Tetonius* shows a striking similarity to the living genus *Tarsius*, a small Primate from the Philippines and the larger islands of the East Indies. This little animal has been usually classed with the lemurs, but exhibits several rather fundamental differences from this group. (Cf. § 10.) Recently numerous anthropoid affinities of *Tarsius* have been pointed out, and some authorities have been led by these to place it as the lowest living member, a little modified, of the true anthropoids.[1] If such be the proper place of Tarsius, and if its resemblance to *Tetonius* is a real one, two suppositions that seem extremely probable, we have here, almost at the outset of Eutherian history, *the establishment of the anthropoid branch, and possibly a direct ancestor of Man in the Middle Eocene of North America.* Indeed it may be further assumed that

[1] Cf. Charles Earle. On the Affinities of Tarsius; a contribution to the Phylogeny of the Primates, in Amer. Nat. July-Aug. 1897; also Hubrecht, on the early embryonic condition of the same animal, Die Keimblase von *Tarsius*. Leipzig. 1896.

Notharctus and *Pelycodus,* in a descending series, belong within or near the ancestral line of *Tetonius,* and thus, in spite of the paucity of the mammalian history in general at this stage, we may have already recovered the line of human ancestry near its very beginning. *Pelycodus* suggests strongly *a close relationship to the earliest Creodonta at the point at which they, in turn, emerge from the Insectivora,* and it may be thus seen that the line of the anthropoids begins far down in the history of the eutherians, almost, indeed, at the very base of the modern type of mammals. Back of these generalized eutherians to the late Jurassic or early Cretaceous forms of the Purbeckian there is interposed the lost interval in which we can be guided only by hypothesis, but those members of the Pantotheria which exhibit a heel on the lower molar teeth suggest that here too we are on the right track, and that the gulf between these forms and the most generalized of the Creodonta is not a wide one, and that the chance discovery of only a few fragments of the right sort may sufficiently illumine this portion of the record.[1]

32. Other Early Primates. Simultaneously with the appearance in North America of the Primates of the Wasatch, the Wind River, and the Bridger, similar animals, usually belonging to closely allied genera, occurred in Europe. Their remains are found in the corresponding stages of the Sparnacian, Ypresian, and Lutetian, that is, during the lower and middle Eocene. Perhaps the best known of these, and the one the most abundant in remains, is *Adapis,* represented

[1] For the paleontological record of the Primates, especially in North America, cf. Osborn, H. F., American Eocene Primates, Bull. Amer. Mus. Nat. Hist., XVI. 17, 1902; Wortman, J. L., Studies of Eocene Mammalia, Part II, Primates, Amer. Journ. Sci., Fourth Series, Vols. XV and XVI, 1908; Matthew, W. D., A Revision of the Lower Eocene, Wasatch, and Wind River Faunas, Bull. Amer. Mus. Nat. Hist., Vol. XXXIV, Art. XIV, Sept. 1915, pp. 429–483. For speculations concerning descent, cf. Loomis, F. B., The Descent of the Primates, Amer. Nat., Aug. 1911; also Earle on Tarsius, previous footnote.

by a number of species, and occurring in such deposits as the Phosphorites of Quercy, and the gypsum of Montmartre. The dental formula, $i\frac{2}{2}\text{-}c\frac{1}{1}\text{-}pm\frac{4}{4}\text{-}m\frac{3}{3}$, with its four premolars, shows a very primitive condition, but in the species *A. magnus* the first premolar is reduced to a rudiment, showing

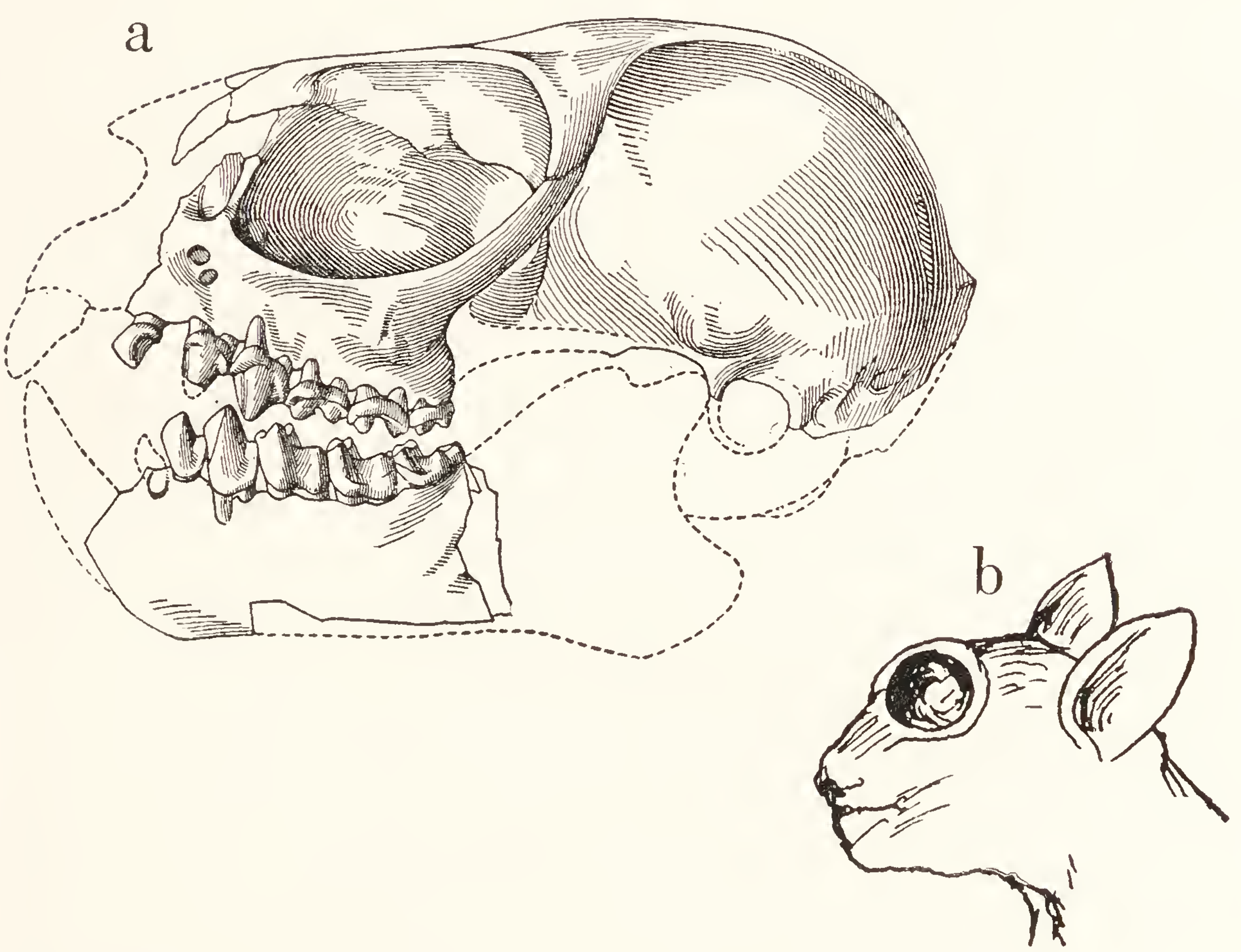


Fig. 26. The most primitive known Anthropoidea.
a. Tetonius, from the Wasatch, built up from fragments. After Matthew.
b. Restoration of the head, natural size.

the way in which, in the next higher stage, the number of these teeth becomes reduced to three. On the other hand a rather special character is seen in the fusion of the two halves of the mandible, and the great width of the symphysis, giving the jaw much the shape seen in *Notharctus*. Filhol, the discoverer of the genus, classed it as a "Pachylemurien," declaring thereby that in his opinion the animal was a link between the true lemurs and the pachyderms, i. e., pigs and hippopotami, then considered as the most primitive

ungulates.[1] Some later writers have considered it a genuine lemur, but it seems best at present to leave it, together with those of the preceding section, as merely an early Primate, representatives of a period in which the distinctions into the modern specialized groups of Lemuroidea and Anthropoidea had not as yet become established.

Another European form, contemporary with, and after-

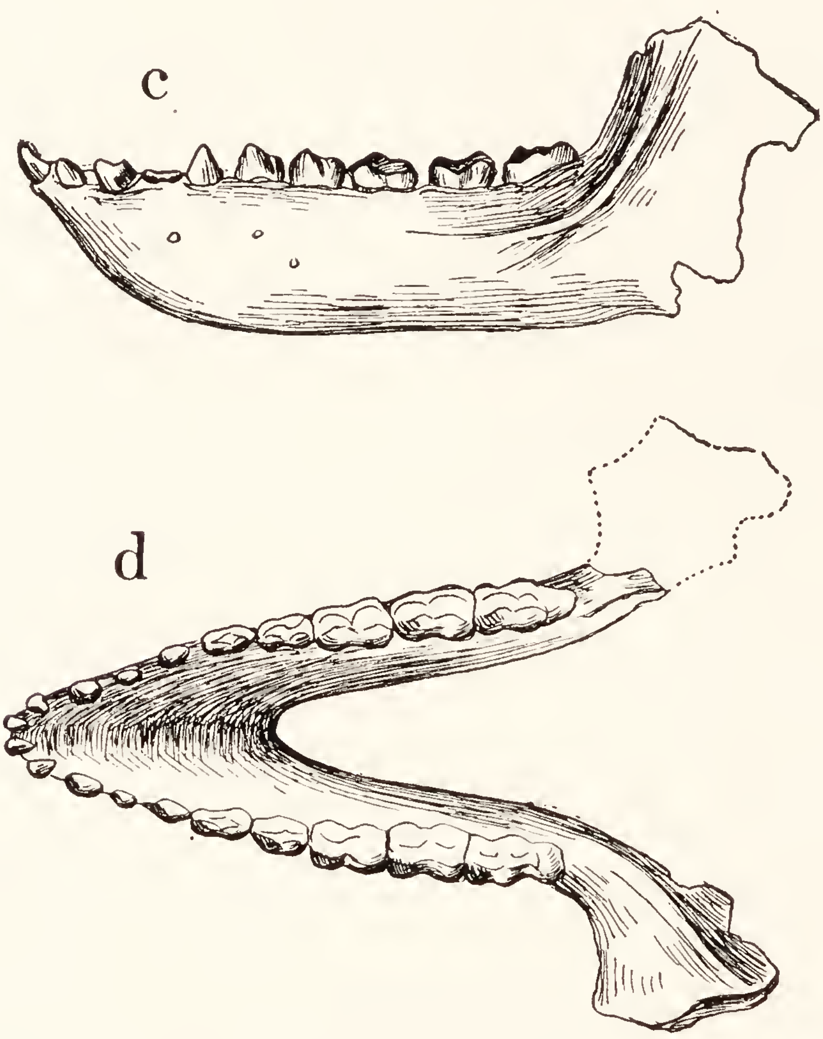


Fig. 26 (continued). *c* and *d*. Two views of the jaw of *Notharctus* (*Tomitherium*) *rostratus* from the Bridger. After Cope.

wards successor to, *Adapis*, persisting well into the Oligocene, was *Necrolemur*, closely related to the contemporary American genera, *Tetonius* and *Notharctus*. In its elongated snout it is nearer *Notharctus*, or even *Pelycodus*, while its greatly expanded orbits are much as in *Tetonius*. Its premolars are three in number, intermediate in this respect between *Notharctus*, with four, and *Tetonius*, with two.

[1] Filhol. Recherches sur les Mammiferes fossiles du Quercy. Ann. Sci. Geol. Is. VII (1876); VIII (1877); and XVII (1885).

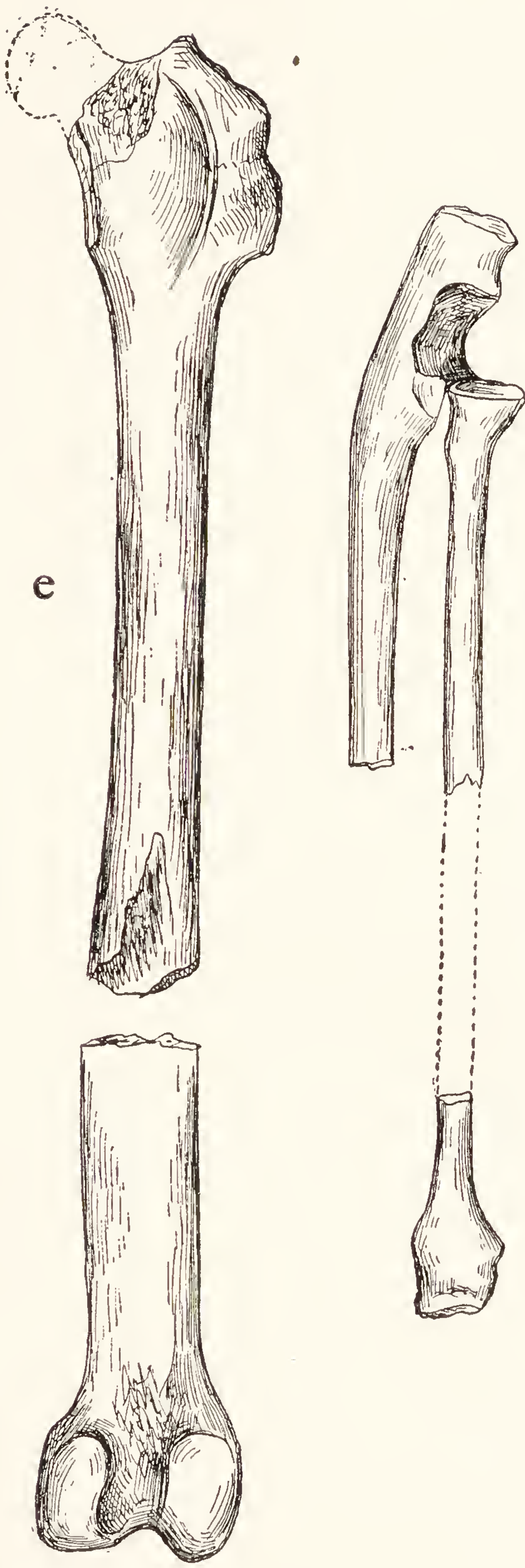


Fig. 26 (continued). *e* and *f*. Bones of the fore-leg of a Primate, probably *Notharctus*, placed by Cope in Genus *Tomitherium*. From the Bridger. After Cope.

To its discoverer, Filhol, *Necrolemur* was, as its name denotes, a true lemur, and he compares it with *Loris* and *Galago*. Cope placed it at first next to *Tetonius*, the two forming the

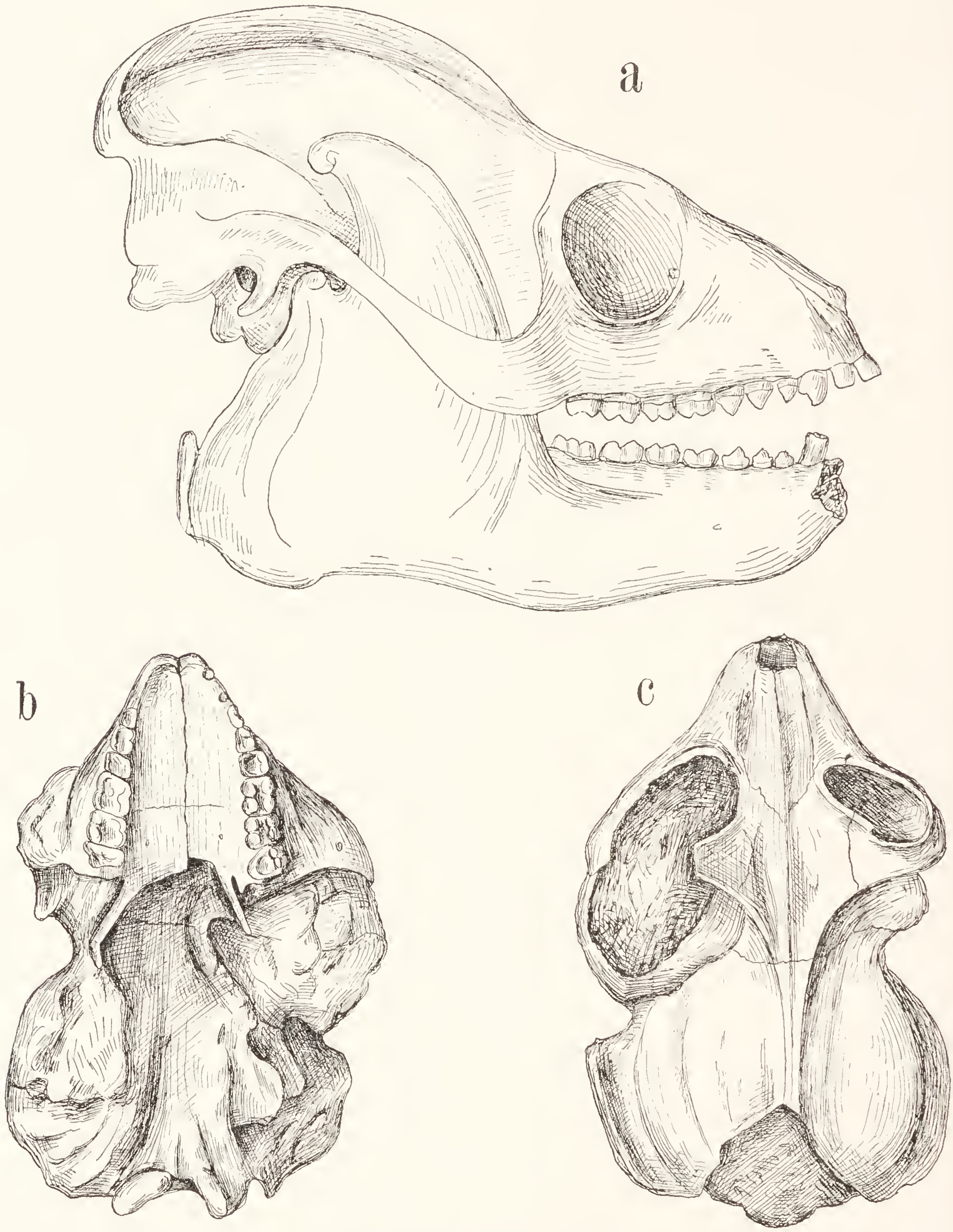


Fig. 27. Three views of the skull of *Adapis parisianus*, an European lemur from the Ypresian and Lutetian formations, and probably a contemporary of the North American *Notharctus* and *Tetonius*. After Filhol.

family, Anaptomorphidae; but almost immediately (in the errata of the same work) removed it to the family Mixodectidae, itself a group of doubtful position (cf. the next paragraph). Winge, the Danish authority, treats both *Necrolemur* and *Tetonius* (*Anaptomorphus*), together with

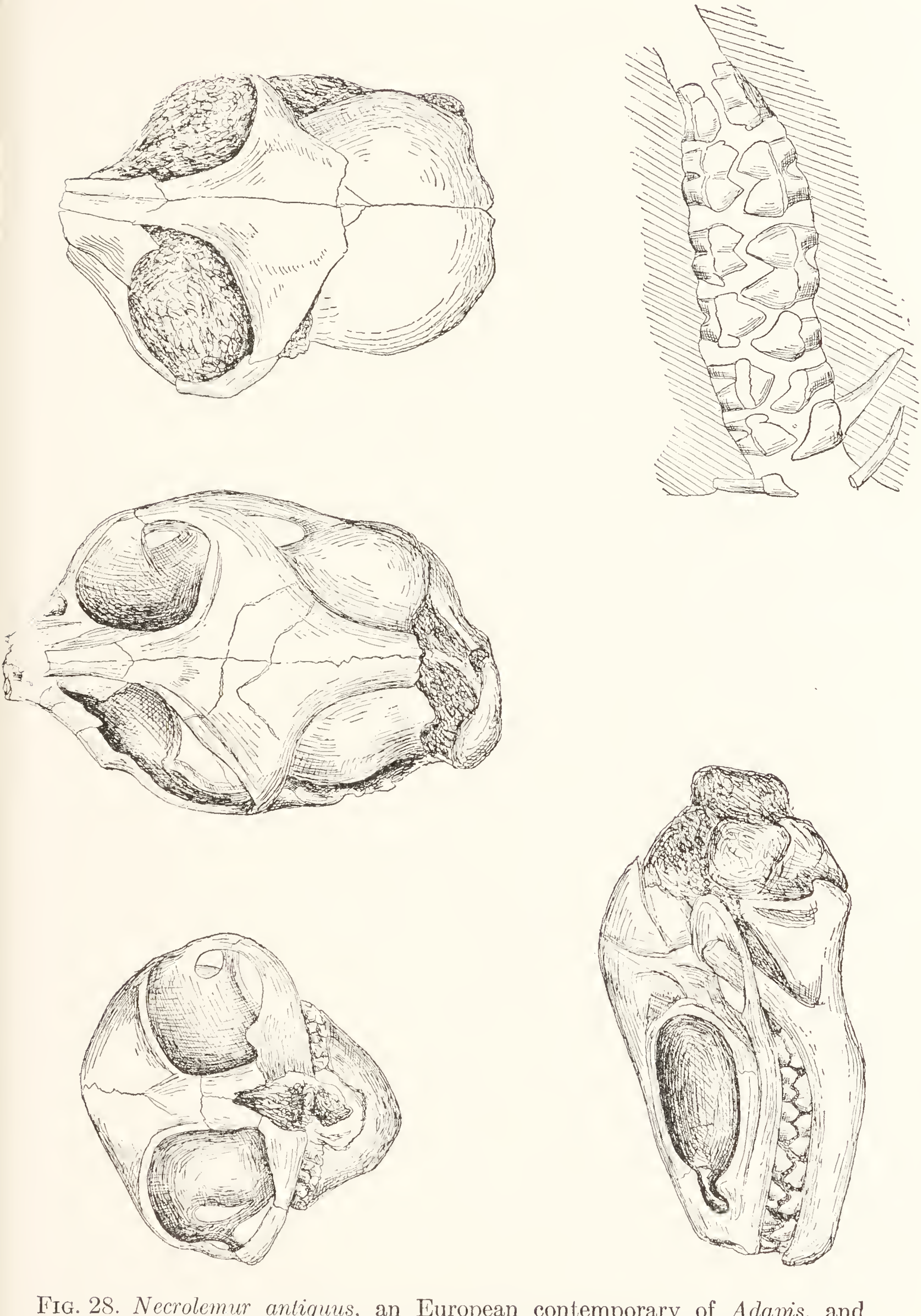


FIG. 28. *Necrolemur antiquus*, an European contemporary of *Adapis*, and also of the North American *Tetonius* and *Notharctus*. After Filhol.

the living form, *Tarsius*, as constituting one group or subfamily (*Tarsiini*) of the family *Tarsiidae*, in which *Adapis* forms another group (*Adapini*).[1]

Two genera, called by their discoverer *Plesiadapis* and *Protadapis*, were found by Lemoine in the Cernay deposit (*Thanetian*), and are consequently among the earliest known European mammals, contemporary with those of the North American Torrejon.[2] Although Lemoine indicated by the names his belief that these animals were Primates, probably related ancestrally to the later appearing *Adapis*, their Primate affinity is now generally doubted, and they are placed, with some hesitation, among the early Rodents. A similar decision has been suggested for certain American forms of the early Eocene, such as *Mixodectes* and *Microsyops*. For the first of these Matthew and Osborn have proposed a new Order, the "Proglires," the direct ancestors of the modern Glires or Rodentia.[3] An alternative hypothesis, which restores all or the most of these Rodent-like forms to the Primates, considers them as representatives of an aberrant line of development, which left the main body of the Primates, differentiating along the line of an excessive development of a single incisor and the reduction or loss of the canine, and is now represented by the single form, the "aye-aye" (*Chiromys*) of Madagascar, at present an unusually isolated animal, but with unmistakable Primate affinities.[4] The skull of this animal shows the result of the differentiation along the line suggested, and its superficial resemblance to a rodent is very striking. If, now, *Mixodectes*, *Microsyops* and their allies be placed with

[1] Winge, H. Jordfundne og nulevende Aber fra Lagoa Santa tc. Copenhagen. 1895.

[2] Lemoine, V. Communication sur les Ossements Fossiles des Terrains Tertiares Inferieurs des Environs de Rheims. Association Franc. Avanc. Sci. Rheims. 1880.

[3] Matthew, W. D., A Revision of the Puerco Fauna, Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897, and Osborn; American Eocene Primates, and the Supposed Rodent Family Mixodectidae, ibid., Vol. XVI, 1902.

[4] Wortman, J. L., in Amer. Journ. Sci. Fourth Series. Vol. XVI. 1903.

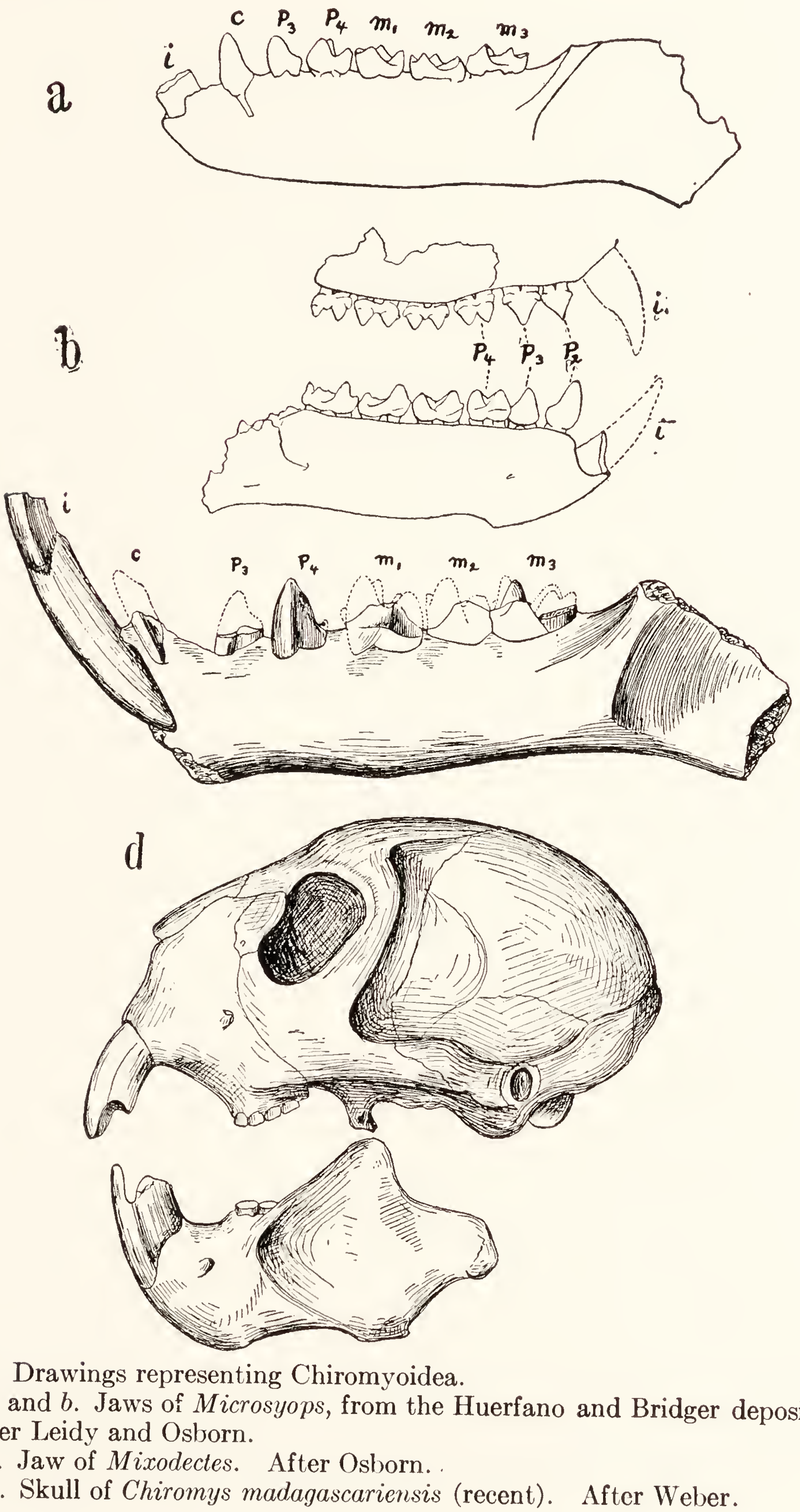


FIG. 29. Drawings representing Chiromyoidea.

a and *b*. Jaws of *Microsyops*, from the Huerfano and Bridger deposits. After Leidy and Osborn.

c. Jaw of *Mixodectes*. After Osborn.

d. Skull of *Chiromys madagascariensis* (recent). After Weber.

Chiromys, they furnish a good series of intermediate forms and remove the latter from its isolation.

Such a proposed series may begin with *Microsyops*, which possesses a single incisor, strongly developed, followed by several teeth of ordinary size, and interpretable either as a small canine, followed by two premolars, or as a set of three premolars, with the canine wanting. In *Mixodectes*, a more advanced stage in the series, the incisor has reached an enormous proportion, and is specialized in shape. The canine is reduced, and an evident diastema occurs between it and the first of the two premolars, the beginning of the isolation of the cheek-teeth.

With our present knowledge of early Primates it is impossible to pronounce judgment on the two above theories, both of which seek to explain the position of the forms in question. *Chiromys* has undoubtedly developed certain characters almost identical with those of Rodents, but whether the two have developed these independently of each other, a case of "analogical resemblance," or whether there was a common ancestry in the early times cannot be known at present, although the former is the more probable. The theory of the rodent affinity of *Mixodectes*, brought forward by Osborn in 1902, associates with it a more primitive form with three incisors, *Olbodotes*, which is not a Primate; while *Microsyops* is set aside as a form of uncertain relationship; the second theory is that of Wortmann (1903), who places together all three genera, *Microsyops*, *Mixodectes*, and *Chiromys*, and forms from them a third Sub-Order of Primates, Chiromyoidea, coördinate with the two long-established ones of Lemuroidea and Anthropoidea. This is the arrangement adhered to in the previous chapter.

33. Extinct Lasiopygidae of Europe. After the Eocene, during which Primates in abundance were spread over North America, this continent seems to have been finally abandoned by all members of the Order until that unknown time, much

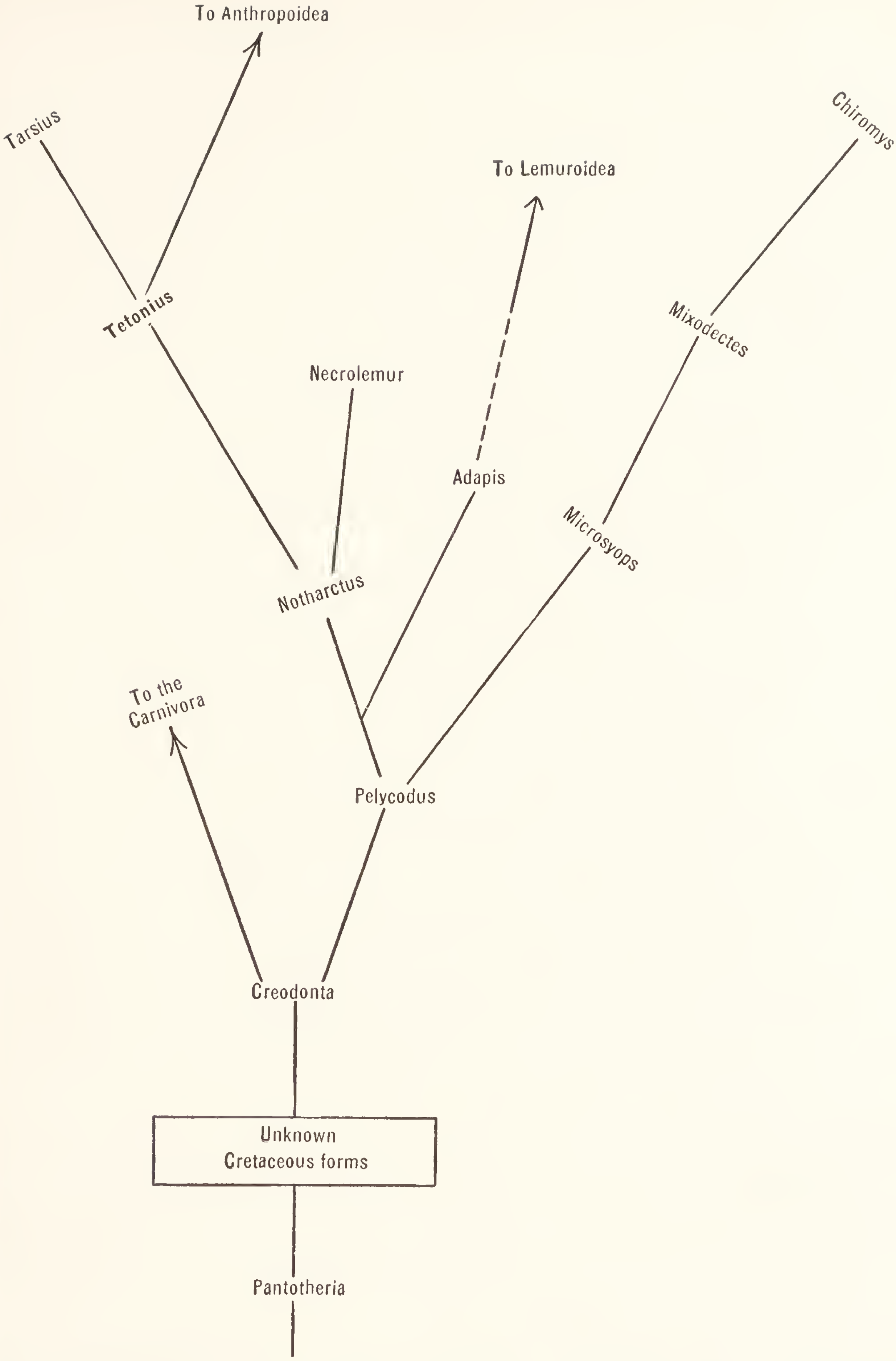


FIG. 30. Phylogenetic tree of the Primates, illustrating the relationships advocated in this book. Through Pelycodus, or a similar form, the Primates have developed from the Creodonta, generalized mammals, the direct ancestors of the Carnivora and other groups. From this leads up the line of specialization into rodent-like forms that terminates in Chiromys, also to the more generalized Notharctus and Adapis, the ancestors respectively of the Anthropoidea and the Lemuroidea. From Notharctus, by a reduction of the snout and other changes, came Tetonius, the direct ancestor of the Anthropoidea of the present time, while one of its descendants, Tarsius, has held quite faithfully to the original form.

later, at which Man appeared within its confines. It seems probable that with the gradual advance of the cooler climate from the north the Primates migrated towards Central and South America, where they later developed in place into the two platyrrhine families of the Callithricidae and Cebidae; but a definite statement concerning this is not yet possible.

a

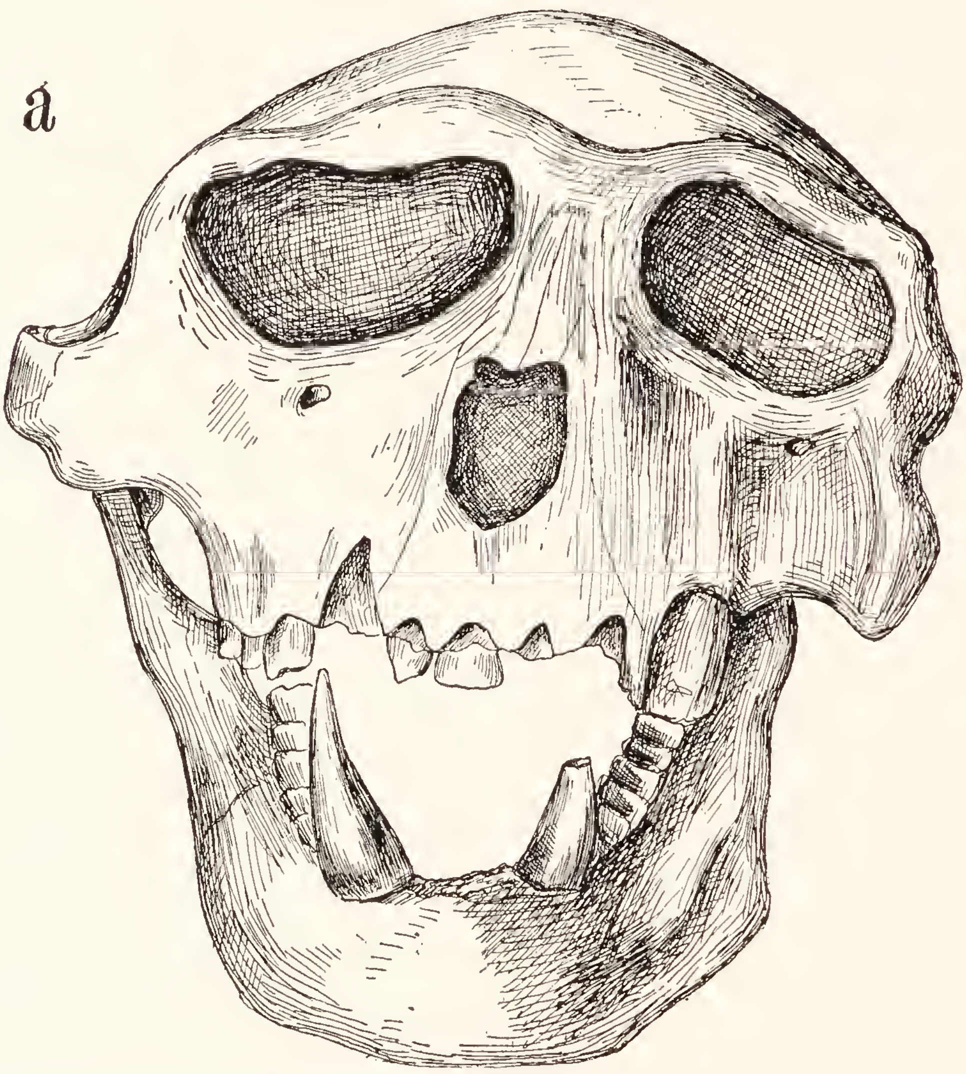


FIG. 31. Extinct European Lasiopygidae. *Mesopithecus pentelici*, from the Upper Miocene of Pikermi, a little to the east of Athens, Greece. The remains of about 70 individuals of this little monkey were found in one place, suggesting a disaster that had happened to a troup of them at one time. It is very much like the modern *Pygathrix*. All natural size. After Gaudry.

a. Entire skull of male from the front.

The key to this question of the origin of these two New World groups undoubtedly lies in the strata of the regions concerned, which are now being sedulously examined by the South American paleontologists;[1] but the data thus far obtained are indecisive and conflicting, and probably do

[1] Ameghino, Steinmann, Lehmann-Nitsche, etc.

not concern our present line of inquiry. In Europe, however, where the history of Man's ancestry seems to have been continued, there was apparently no time, from their first appearance in that continent, in which it was wholly abandoned by representatives of the Primates. Thus with the beginning of the Miocene genuine anthropoids, of the catarrhine, or Old World type, make their appearance. Deperet explains this phenomenon as one of the results of three great migrations from Africa that occurred during the Miocene epoch,

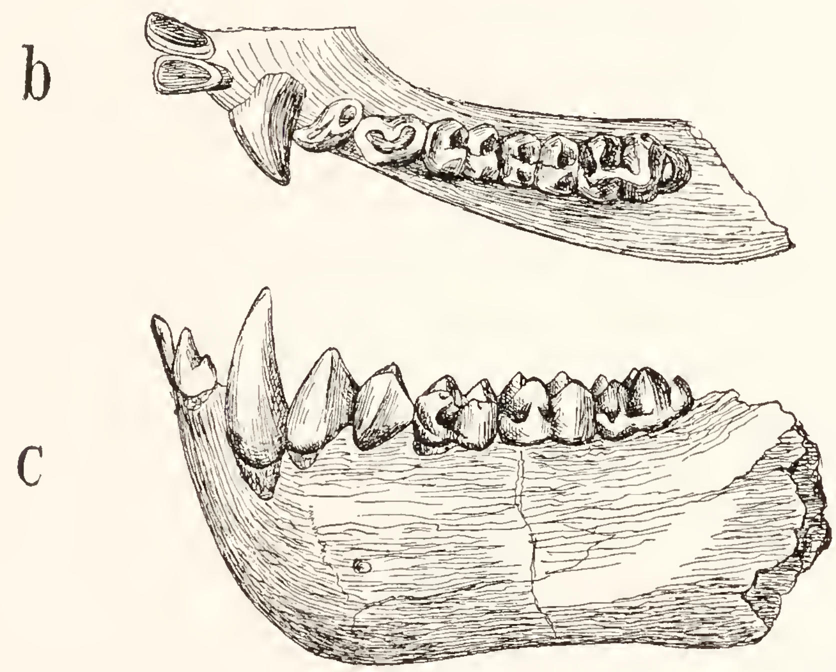


Fig. 31 (continued). *b.* Mandible, masticatory surface.
c. Mandible from the side.

the first in the Burdigalian, the second in the Middle Miocene, between the Helvetian and the Samartian, the third in the Pontian. In favor of this and in opposition to the theory of local development is the irregular manner of their appearance, since *Pliopithecus*, the oldest known, is a simian ape, while *Mesopithecus*, a genuine Lasiopygid monkey, is one of the latest.

The Miocene Lasiopygids of Europe consist of two Genera; *Oreopithecus*, from the Italian deposits of Monte Bamboli, in Tuscany, and *Mesopithecus*, from Pikermi, a few miles from Athens, in Attica. The first is the earlier, and belongs to Deperet's second migration from Africa; the

latter is Upper Miocene, and is referred to the third migration.[1]

Mesopithecus, of which the skeleton is now completely known, part by part, as put together from the remains of upwards of seventy individuals, is a more typical Lasiopygid than *Oreopithecus.* Its head is almost that of the modern genus *Pygathrix,* now confined to Asia, but its very robust limbs remind one of the modern genus *Pithecus,* also Asiatic.

a

b

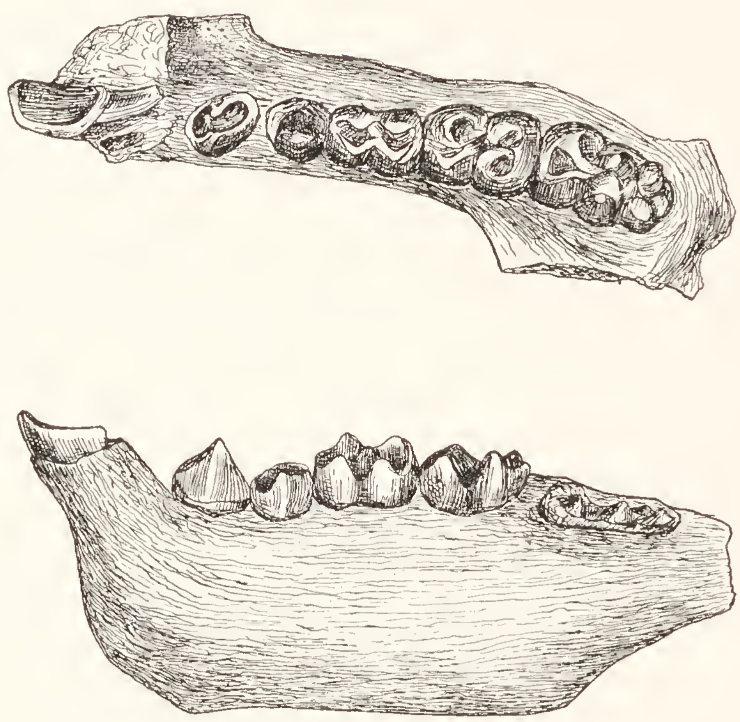


Fig. 32. *Oreopithecus bamboli,* from the Miocene of Monte Bamboli in Tuscany. Two views of the mandible; natural size. After Gaudry.

From the occurrence of so many associated individuals in the Pikermi deposit, a gregarious habit has been inferred, and from the shape of its limb bones it seems to have been better fitted for clambering about on the rocks than for climbing on trees.

The remains of *Oreopithecus* are quite fragmentary, and the animal has been described as an intermediate form between the lasiopygids and the hominids. It approaches the latter

[1] *Mesopithecus,* discovered by Roth and Wagner in 1840, is described by Gaudry, Animaux fossiles et geologie de l'Attique, Paris, 1862, and by Veithofer, Beiträge zur Kenntniss der Fauna von Pikermi, bei Athen, in Beiträge zur Paleontologie Oesterreich-Ungarns, Bd. V, 1888. For this and other fossil Apes, cf. also Gaudry, Enchainements du Monde Animal dans les temps geologiques; Mammiferes Tertiares. Paris. 1878.

group in its short face, its rounded chin, and in the relative size of the first premolar, which is larger than the second.

A third European lasiopygid, but too recent to be of value in the present discussion, is *Dolichopithecus*, a Pliocene monkey, found at Montpellier, in France. It was larger than *Mesopithecus*, and possessed a more prominent snout.

34. Extinct Hominidae of Europe. These consist of two genera, each represented by a single species: *Pliopithecus antiquus* and *Dryopithecus fontani*. The first, which, in spite of its name, is not Pliocene but Miocene, occurs in the Middle Miocene deposits of Sansan, France, and is assumed by Deperet to have entered Europe from Africa with the first of the Miocene invasions. It appears to be closely related to the gibbons (*Hylobates*), and would be more appropriately named *Prothylobates*. As the gibbons are now, not merely Asiatic, but limited to the eastern portion of that continent, especially the East Indian Islands, this is one of the many proofs, if proof were wanting, of the extensive early migrations of the various animal groups.

The second form, *Dryopithecus*, is also a Miocene ape, one of the most important extinct lower anthropoids yet known. It is best described as a generalized simian, though approaching the chimpanzee and gorilla rather than the orang or the gibbons. In size it is about that of a chimpanzee, but in the anterior divergence of its line of lower molars, i. e., the first molars being a little farther apart than the third, it resembles the gorilla. On the other hand the length of its mandibular symphysis is excessive for a simian ape and is nearer that of the Lasiopygidae.[1] Its name,

[1] Gaudry, A. Le Dryopitheque; Mem. Soc. Geol. France. Paleontologie. 1890.

Schlosser. Die menschenähnlichen Zähne aus dem Bohnerz der schwäbischem Alb. Zool. Anz. Bd. XXIV. 1901.

Abel, O. Zwei neue Menschenaffen aus der Leithakalkbildung des Wienerbeckens. Sitzungsberichte der K. K. Acad. zu Wien, 1902. (This paper furnishes a résumé of the subject of European simians.)

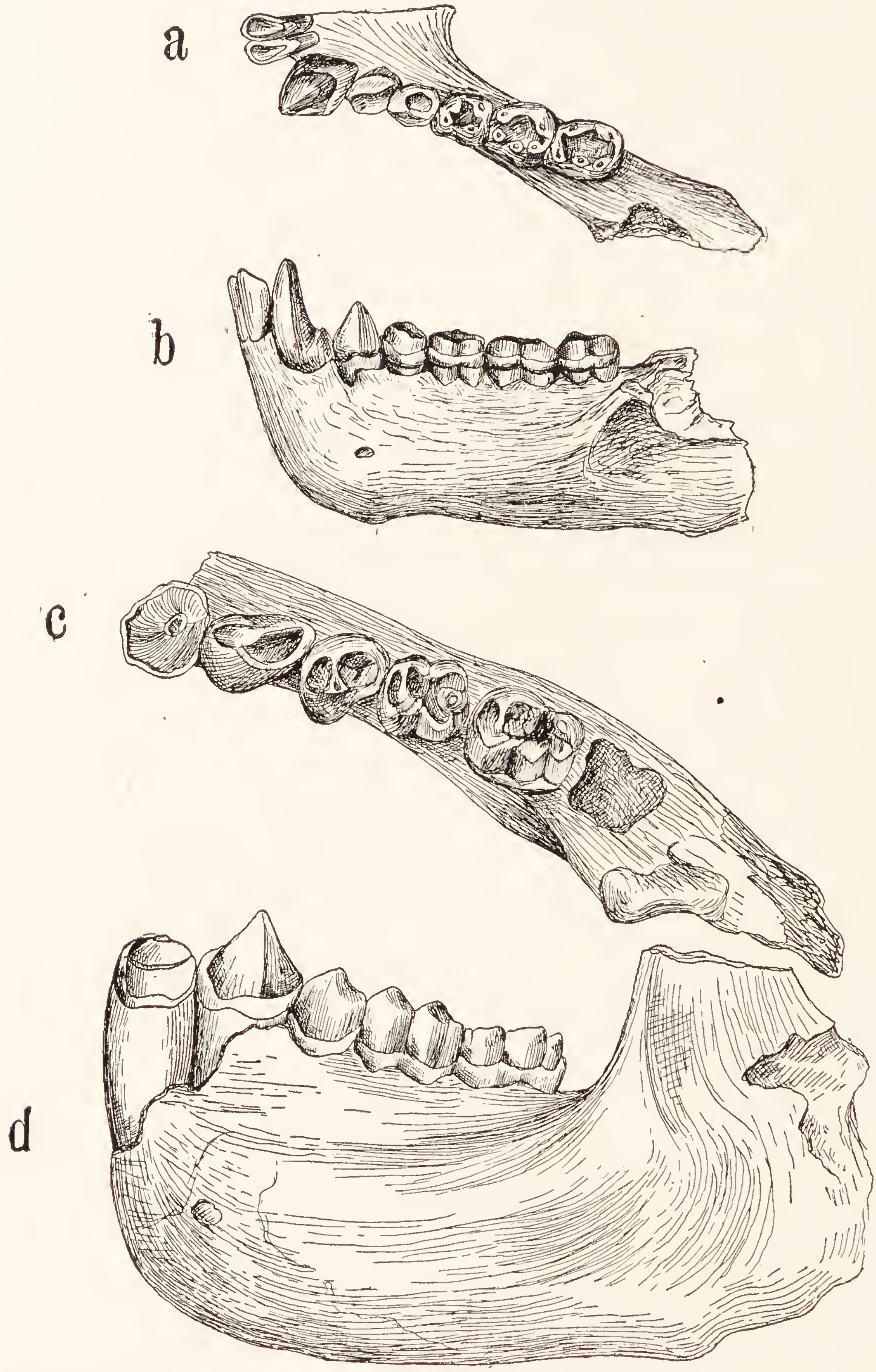


Fig. 33. Extinct European Hominidae.

a and *b*. Pliopithecus antiquus, from the Middle Miocene of Sansan, Southern France. This animal much resembled a gibbon.

c and *d*. *Dryopithecus fontani*, from the Miocene of St. Gaudens, in the northern border of the Pyrenees. This was something like a chimpanzee, but more generalized.

Both specimens are drawn natural size. After Gaudry.

Dryopithecus or oak-ape (δρύος-πίθηκος), comes from the association of impressions of oak leaves with the remains, which suggests that it was an inhabitant of the oak forests. It recently has received a new and unexpected interest through its possible connection with contemporary flint fragments (eoliths), which, though not shaped into tools, show the marks of use in hands shaped like those of Man. This connection is but a remote one, yet at present no other contemporary remains are known to which to attribute the marks seen on the flints in question.[1]

35. Extinct Hominidae of Asia and the Adjacent Islands. While, rather unexpectedly, the strata of Central Europe have yielded numerous types of extinct anthropoids, it has been generally felt that the essential part of the early history of the Old World anthropoids, including Man, lies in the soil of Southern Asia and the large islands to the east of it. Indeed, the slight amount of research already undertaken, chiefly in India and in the island of Java, has furnished material of vital importance.

An important species is the large simian of the Sivalik Hills in India, *Palaeopithecus sivalensis.* By some it has been considered a true chimpanzee, and placed with it in the genus *Pan,* now confined to Equatorial Africa; it is, however, more man-like than the Chimpanzee, and is best referred to a distinct genus. In comparison with the chimpanzee its canine and lateral incisor teeth are much reduced, and the two lines formed by the lower molars converge anteriorly, this character lying midway between the condition in the chimpanzee, in which the two rows are parallel, and that found in Man, where marked anterior convergence of the rows of lateral teeth results in the formation of a gentle curve.

[1] A recent expedition from the American Museum of Natural History has reported on the fragments of three monkey jaws, which have been placed by them as three new species of the Genus *Dryopithecus.* They were found in the Sivalik Hills of India.

By far the most important discovery as yet from this little studied portion of the globe is that of the ape-man, *Pithecanthropus*, found in Trinil, Java, in 1891-1892 by Dubois.[1] The remains consist of a cranium, without jaws or facial bones, a femur, and four teeth; yet, incomplete as they are, they happen to be the very parts most essential for obtaining an idea of the general structure. They were found at different times and not in contact with one another, but were at exactly the same level, and so placed with reference to the geological formation that it is practically certain that

a b

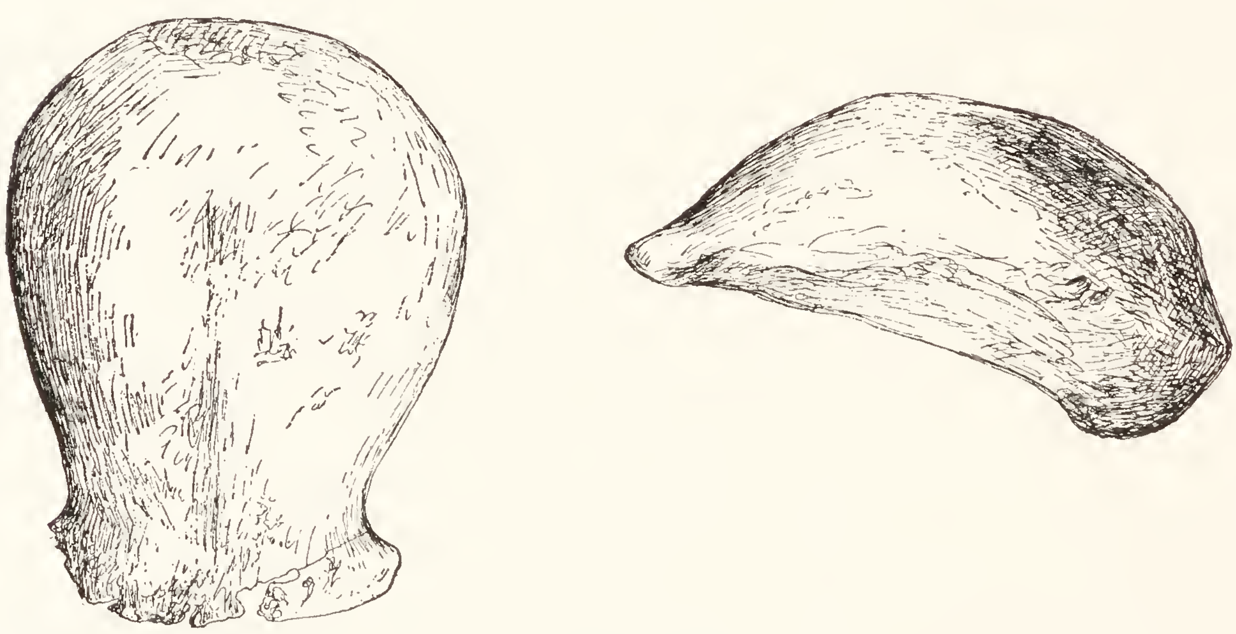


FIG. 34. *Pithecanthropus erectus*, the transition form from Trinil, Java. After Dubois. *a*. Calvarium, from above, x ½; *b*. Calvarium, from left side, x ½.

they belonged to the same individual. The details of the discovery, and the comparison with related forms, are treated in the next chapter.

Concerning the phylogenetic position of this remarkable fossil opinions diverged widely for a time. Some (Virchow, Waldeyer) have considered it an ape; others (Turner, Cunningham, Lyddeker, Topinard) a man; and still others (Schwalbe, Manouvrier, Marsh, Haekel, Duckworth, and the discoverer himself) a transition form between the two. Since, however, the first school acknowledged

[1]Dubois, E. Pithecanthropus erectus; eine Menschenannliche Uebergangsform aus Java, Batavia, 1894; also in Anat. Aug., Bd. XII, 1896.

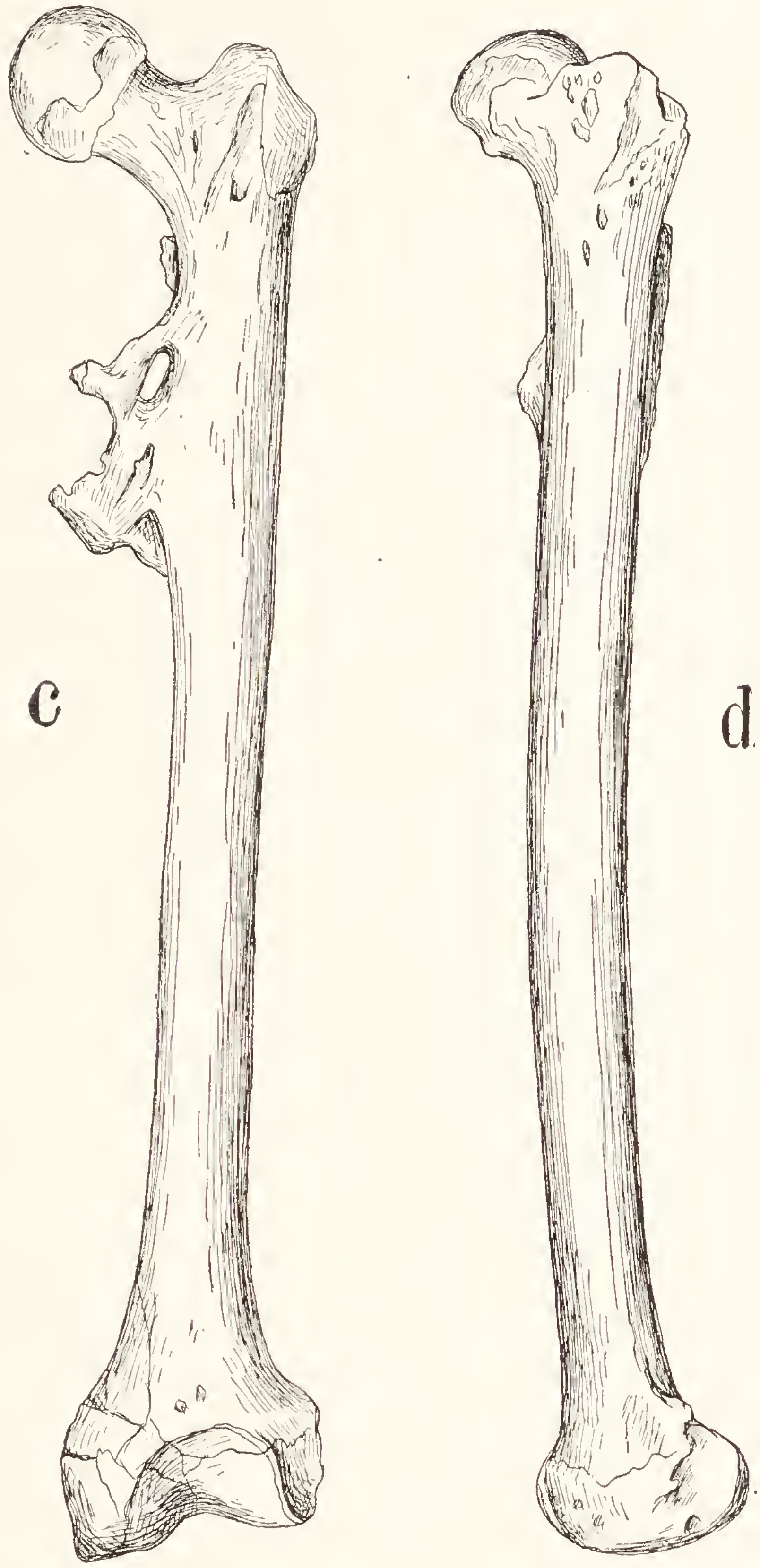


FIG. 34 (continued). *c* and *d*. Two views of the very straight femur, x ⅓. The excrescence on the side, below the head, is pathological, and due to a severe injury during life.

that it was a higher ape, and the second a lower man, than any yet known, they virtually met at about the point held by the third, and the controversy became mainly a matter of definition. The third school, strengthened by the painstaking and scholarly comparisons of Schwalbe, which form a

mathematical demonstration in favor of an intermediate position, seem at present to have prevailed, and we may consider that in *Pithecanthropus* we have a transitional form lying either in the direct line of human descent, or removed from it to a slight degree through specialization, practically the "missing link" of former popular demand.[1] It was in acknowledgment of this view that Dubois employed the name *Pithec-anthropus,* which not only combined the two words, πίθηκος, an ape, and ἄνθρωπος, a man, and was the term suggested previously by Haeckel, to denote the then hypothetical transition form. Haeckel's specific name *alalus* or the "speechless," Dubois could not adopt, since from the proportions of the teeth found he was enabled to reconstruct the palatal arch, which had the proper shape to allow a few articulate sounds; he therefore substituted for this the name "*erectus*," in allusion to the important, though unexpected character shown by the straight femur.

The assumption for this fossil of the power of speech has received further corroboration from the study of the intercranial cast, which gives the outer form of the brain, covered by its wrappings. In this the "speech-center," the left lower frontal gyrus, shows a development in excess of that found in the apes, but considerably less than that of modern man, suggesting an intermediate character in the exercise of that function.

Another extinct transition form, perhaps even more important than *Pithecanthropus,* has been recently discovered in Bechuanaland by Professor Raymond Dart of Johannesburg. It has been named *Australopithecus africanus,* and is an immature specimen, representing a child of six (cf. Fig. 42½). As we may place both *Pithecanthropus* and *Australopithecus* within Sub-Family 3, Homininae, further study of both will be reserved for the next chapter.

[1] Schwalbe, G. Studen uber Pithecanthropus erectus, Dubois. Zeitsch. Morph. u. Anthol., Bd. 1, 1899.

CHAPTER III.

FOSSIL MEN

36. The Skeleton of the Neander Valley. It will be remembered that a century ago the atmosphere was not especially favorable to the unearthing of prehistoric human remains, especially when these showed anatomical characters approaching the humbler and more definitely bestial Primates. In those times, in fact, but slight attention was paid to anatomical details, and it has been reported that of the eleven thousand virgins preserved in Cologne several showed the double terminal metacarpal joint characteristic of ruminants. If we remain on sure ground it is certain that a fossil salamander allied to *Cryptobranchus* was put in a church and bore the label "Homo Diluvii Testis." To mistake this amphibian for a man gave abundant evidence that the anatomical observation of those times was certainly at a low ebb.

When, now, an entire human skeleton was found in a small grotto high up on the side of a ravine of the river Neander, and when it showed unmistakable evidence that it had distinctly a lower head and a more retreating forehead than in any human skull of the present species, it created a revolution. Unfortunately the position gave no clear proof of extreme age, for, while it seemed probable that the body had been washed into the grotto at a time when the level of the river was placed at its mouth, and hence long before the ravine was excavated half as deeply as at present, there was also a crevice that led into it from above, after the manner of a manhole, thus rendering it possible that it might have been introduced in that way.

The prevailing opinion was greatly strengthened by the pronouncement of the great pathologist Rudolf Virchow, who thought it might very well have been a lost soldier

from one of Napoleon's expeditions, and that the unusual shape was pathological. In other words the man had been a congenital idiot! It is no wonder that the remaining bones of the skeleton were stored away in the museum without further investigation, although the skull, which had meanwhile been manifolded through plaster casts and thus widely distributed, held for some further time an important place among archeological objects, and that many in spite of Virchow still believed it that of an extremely ancient man, perhaps even that of an antediluvian species.

It is also no wonder that a similar skull, unearthed at Gibraltar a few years earlier, met an even more ignominious fate, and was brought to light a second time on a museum shelf in association with some old shards, the whole labeled "Pottery."

37. Establishment of the Species Homo Neandertalensis. There is no need of recounting here the history of the finding of other skeletons similar to this man from the Neander Valley. It is sufficient to say that at the present time this type is known from some ten skeletons practically complete, aside from a large number of fragments, among which occur unmistakable parts showing the characteristics of the species.

The first two of these were found in the cavern of Spy in Belgium, and consisted of a larger and a smaller Spy skeleton, of which one possessed a nearly complete mandible and several facial bones, including one side of the upper jaw. The most important of the facts thus discovered was the chinlessness of the jaw, the profile contour of which sloped directly backwards from the teeth, without a trace of the forward projection, so characteristic of the recent species. The smaller of the two Spy skeletons was probably that of a female; the larger a male.

The attention being directed to the three representatives of this ancient type of man, the Neandertal and the two

Spys, further consideration was given to the "Gibraltar" skull, which before long was suspected of being also a female. In this skull, which preserved a large part of the face, there was seen the enormous, round orbits, quite different from the modern type. Even the Neandertal cranium, rather the poorest of all, showed as a striking character heavy and projecting brow ridges, which were much stronger in the males, and which must have offered good protection for the enormous eyes which, judging from the Gibraltar relic, they must have possessed.

Thus far all the representatives of this species came from Western Europe, but the eastern part of the continent was heard from in 1891 through the gruesome discoveries in Croatia, near Agram (Zagreb) of several Quaternary hearth-sites, consisting of pebbles showing the marks of fire, fragments of charcoal, ashes, and the broken pieces of ten human skeletons, men, women, and children, too evidently the remains of cannibal feasts. The detailed investigation of these fragments revealed jaws without chins, heavy, beetling brow ridges, and all the characteristic marks of the Neandertal species, save that in proportion they were brachycephalic, or short-headed, instead of dolichocephalic, or long-headed, as were the others.

After this the discoveries of skeletons of the Neandertal type were reported thick and fast. The skeleton of a young boy was found in the cavern of Le Moustier, evidently an intentional interment, the body placed on one side, with the head resting upon a block of flint and with the arm bones associated with flint implements. One flint axe in particular lay in just the distance relative to the hand to have been originally placed in the boy's hand, allowing for the disintegration of a wooden handle. Others were found in other parts of France, at Le Ferrassie, at La Quina, etc., but the most complete one was found in a cavern long noted for its abundance of paleolithic remains, La Chapelle-aux-Saints. Hither came, during the spring vacation, two young priests,

long accustomed to collect paleolithic flints in that spot, and here the younger brother of one of them struck his pick into the famous skull, thus making the discovery. This was the skeleton of an old man, and, owing to the completeness of the face, took rank with the Gibraltar cranium. It was the most complete male of this species as the Gibraltar skull was the female.

The pronouncement of Virchow concerning the species,

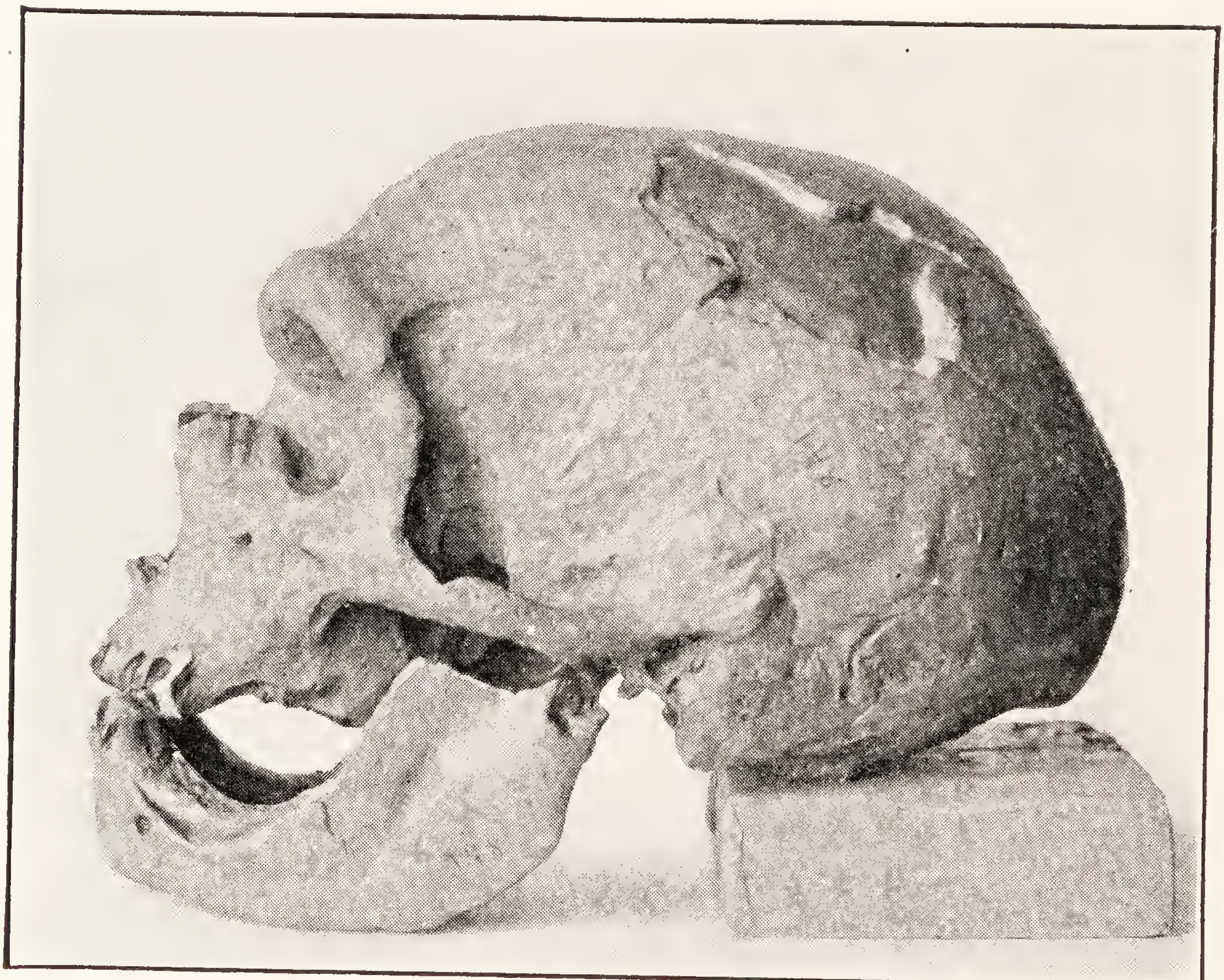


FIG. 35. Cast of skull of La Chapelle-aux-Saints, excavated in 1909; side view. The hole is well seen where the pick, wielded by the boy, entered when the discovery was made.

which had seemed at first so final, and had prevented for many years all study of the bones associated with the skulls, had lost its force by the repeated discovery of more of the same sort, and the Neandertal type of early man gradually assumed shape. Owing to the interest in skulls and jaws, the head was correctly pictured with its low cranial dome and retreating forehead, its heavy eyebrow ridges stronger in

the males, and its chinless jaw, the contour sloping back as do those of the apes and monkeys, but now came a gradual realization of the rest of the body. Quite contrary to expectation the arms were short rather than long, and the pronounced outward curve of the radius suggested a broad interosseous ligament furnishing a broad attachment for the finger muscles, and emphasizing the strong flexor muscles

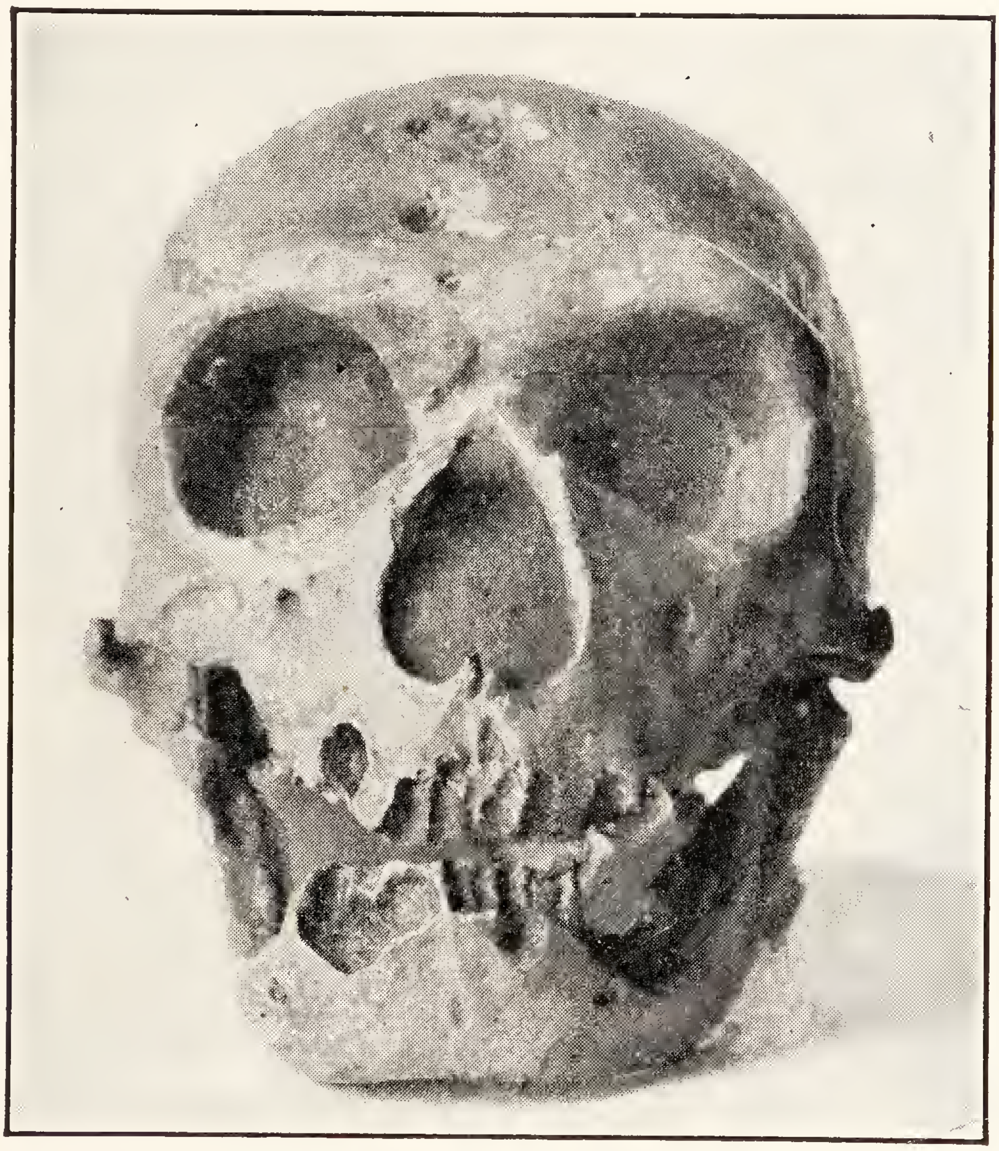


Fig. 36. Same cast as Fig. 35; front view. Note the large size of the orbits.

of the fingers. It thus showed marked ability to live easily in trees.

The short legs were curved in two ways. First, the shaft of the femur was curved forwards, thus rendering the leg permanently bowed, but again the proximal end of the tibia was retroverted to a degree far beyond that of modern man, and thus the knee joint could not be straightened beyond a certain point. The heads of the femora, moreover, were of a

gigantic size, further suggestive of a massive hip joint and the ability to climb trees. The chest circumference was capacious, as shown by the curve of the ribs, and it was certainly well, not only for the Neandertal man himself

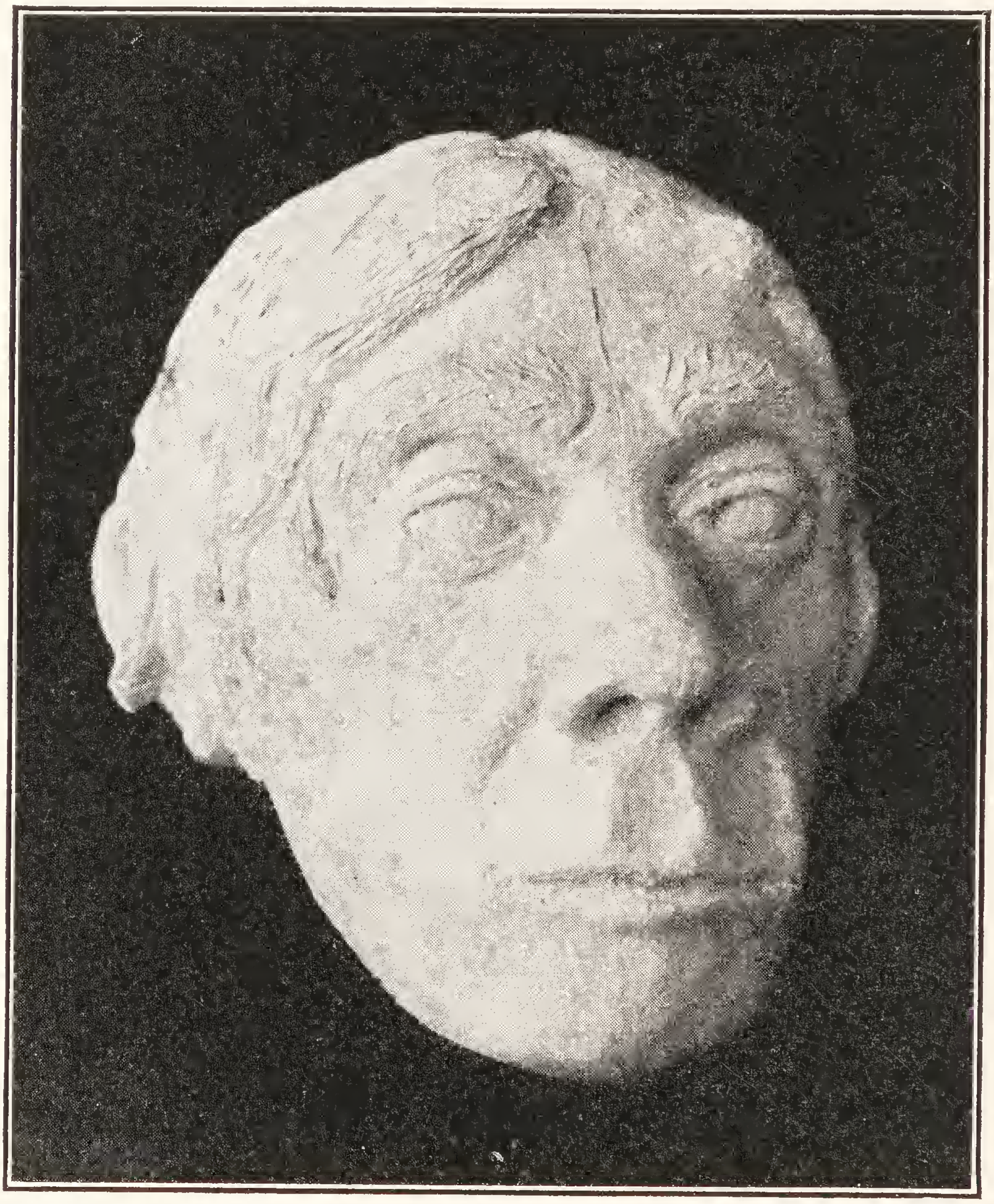


Fig. 37. Restoration of the face of the La Chapelle-aux-Saints skull, made by the author upon a rejuvenated skull supplied by his friend, Dr. J. H. McGregor.

but for all who have followed him, that he was endowed with vast physical strength, for it was his task to exterminate the huge cave-bear, which disputed with him the possession of the caves.

Thus, then, with the continued study of the Neandertal type, it became evident that we were dealing with a creature specifically distinct from the present species, *Homo sapiens* of Linnaeus, and one which became extinct during prehistoric times, already possessed of crude flint tools and weapons.

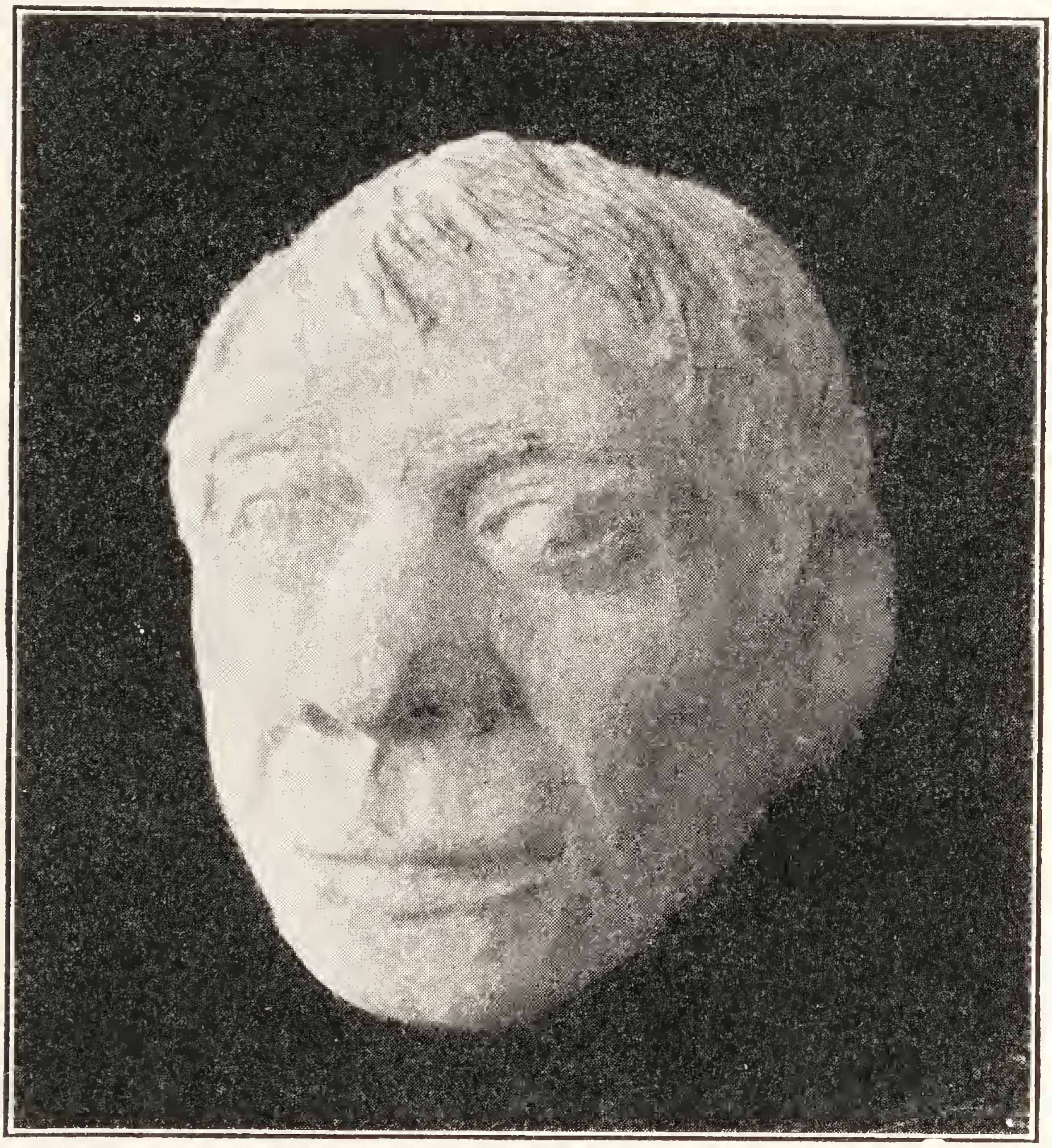
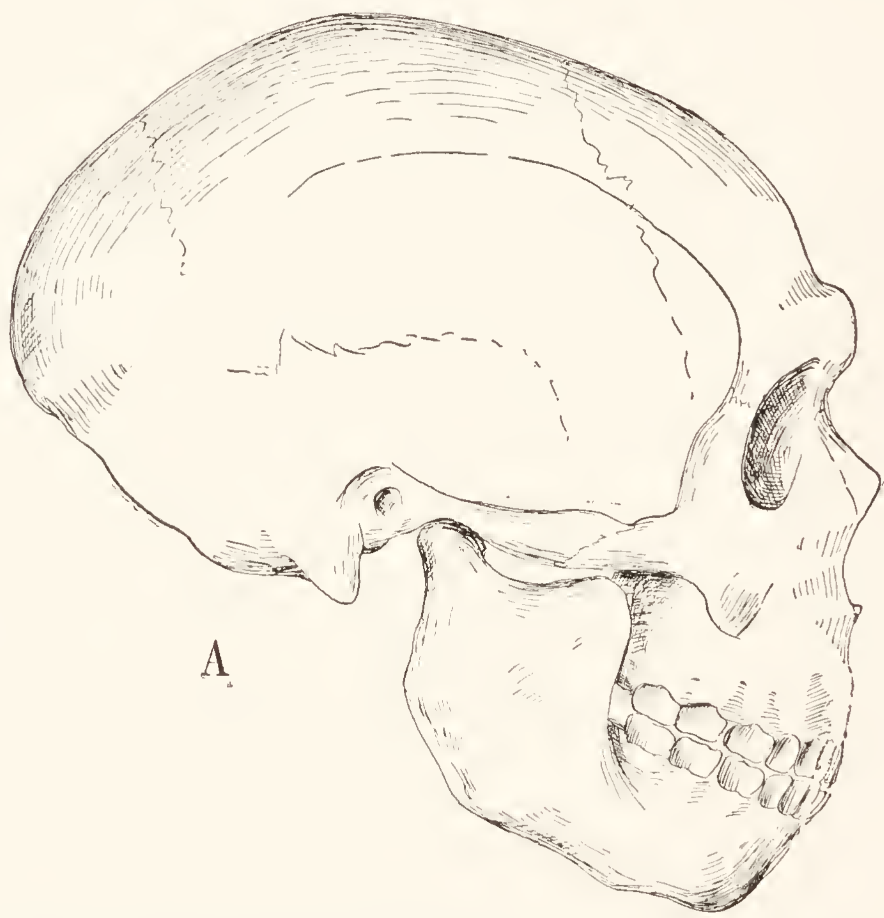


FIG. 38. Restoration of the face of the Gibraltar skull, presumably a female of the Neandertal type. This restoration, like the one in Fig. 37, was based upon a complete skull (cast) lent the author by Dr. J. H. McGregor.

His brain was large, for the skull, although curiously shaped and reminiscent of the apes, showed very large dimensions. Of all the skulls of that species, there is scarcely one but what measures more than 200 mm. in length, a figure seldom attained by the modern species.

The first definite separation of this species from *Homo*

sapiens came from the careful investigations of Schwalbe, mainly through the establishment of certain measurements and indices, like the calvarial index, which differed from all specimens of the modern species by too many points to allow it to be considered as a fluctuating variation, and suggested the need of making it a species distinct from *H. sapiens.* For this Schwalbe suggested the name of *H. primigenius,* but this name has been now generally replaced by the older name of *H. neandertalensis,* from the type specimen. This gives definitely two distinct species to the Genus *Homo.*



A

Fig. 39. A. Skull of Homo neandertalensis, drawn from a cast of Dr. J. H. McGregor's rejuvenation of the Chapelle-aux-Saints specimen.

38. The Heidelberg Man: Homo Heidelbergensis. In 1907 an important fragment of a third species was discovered by Dr. Otto Schoetensack of Heidelberg. It consisted of a jaw only, yet one sufficiently unlike the jaw of *H. neandertalensis* to be considered by all specifically distinct from it. This jaw, nearly perfect, and fully equipped with teeth, was found in a gravel pit 15 kilometers south of Heidelberg which has long furnished gravel for building purposes, and

from which for years the teeth and bones of ancient species of animals had been collected. When this piece was found the director sent it to Prof. Schoetensack and the following year appeared a detailed description of it by its possessor. This jaw was not really human, and differed from that of modern man in the same peculiarities as did the Neandertal type. It was chinless, and exhibited a broad ramus with but a slight mandibular notch.

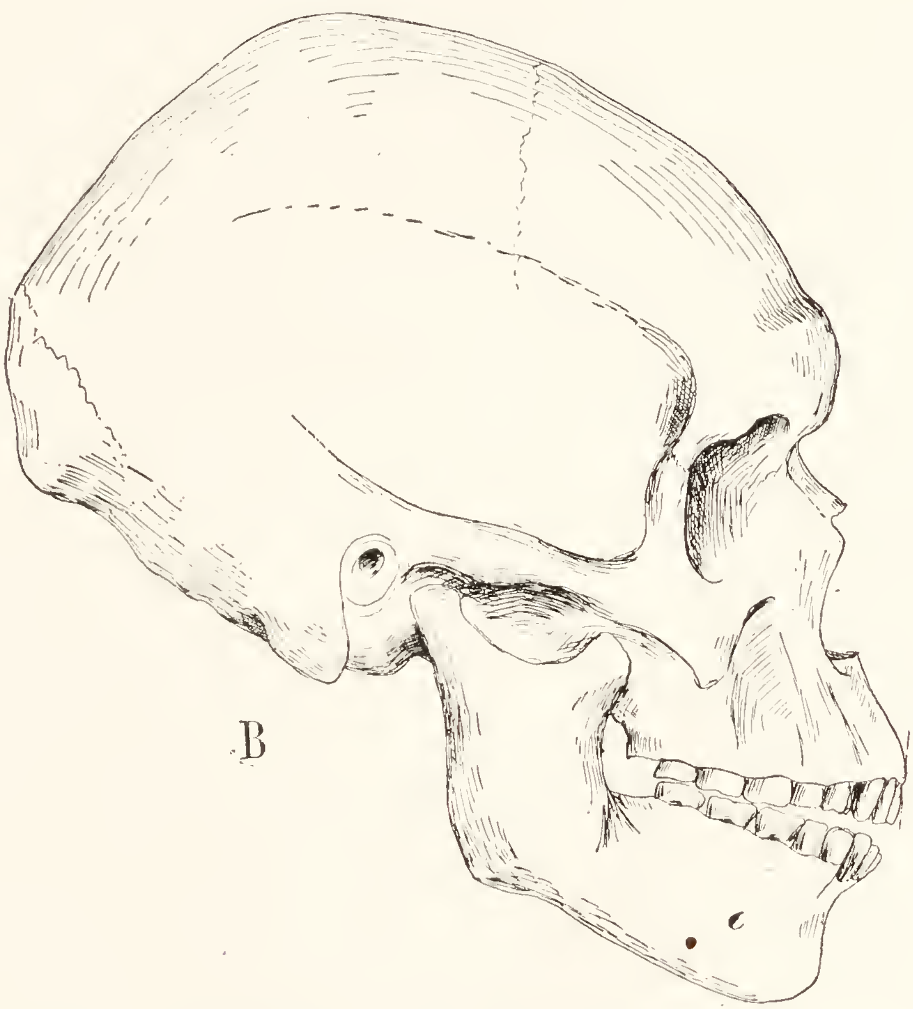


Fig. 30 (continued). B. Skull of Australian native, drawn from a cast in the Klaatsch Collection, K. 71; male; head index $\frac{127}{195}$ 65.14.

39. The Piltdown Man: Eoanthropus Dawsoni. On Dec. 18, 1912, Mr. Charles Dawson, the geologist, and Dr. Smith-Woodward, the paleontologist, exhibited before the Geological Society of London some fragmentary bones obtained from a very ancient gravel pit near Piltdown, Sussex. These consisted of isolated fragments, but as they were not duplicated, and were all possessed of an extraordinary thickness, it was assumed that they belonged together.

From these was constructed a skull, and as the lateral parts of one side could be reproduced on the other, a tolerably complete reconstruction was made. In this way the greater part of the cranium became definitely known, but no facial

a

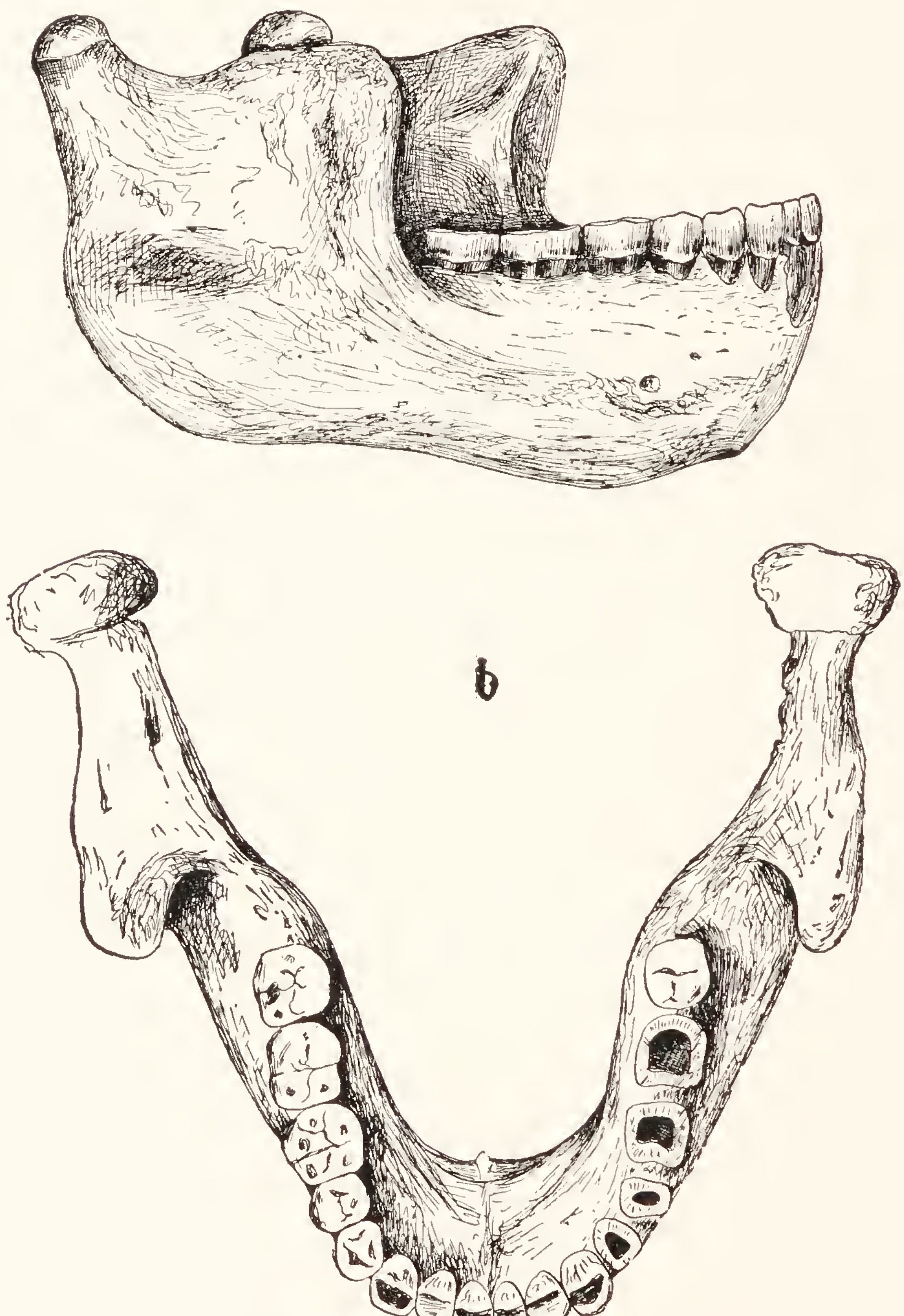


FIG. 40. Two views of the Heidelberg jaw, after Shoetensack. From Wilder, Man's Prehistoric Past. Courtesy of the Macmillan Co.

bones were found except the two nasals, which were complete. The jaw upon one side was nearly whole, and in front a spicule of bone reached almost to the median line, so that, by restoring the other half, the left, the two could be adjusted.

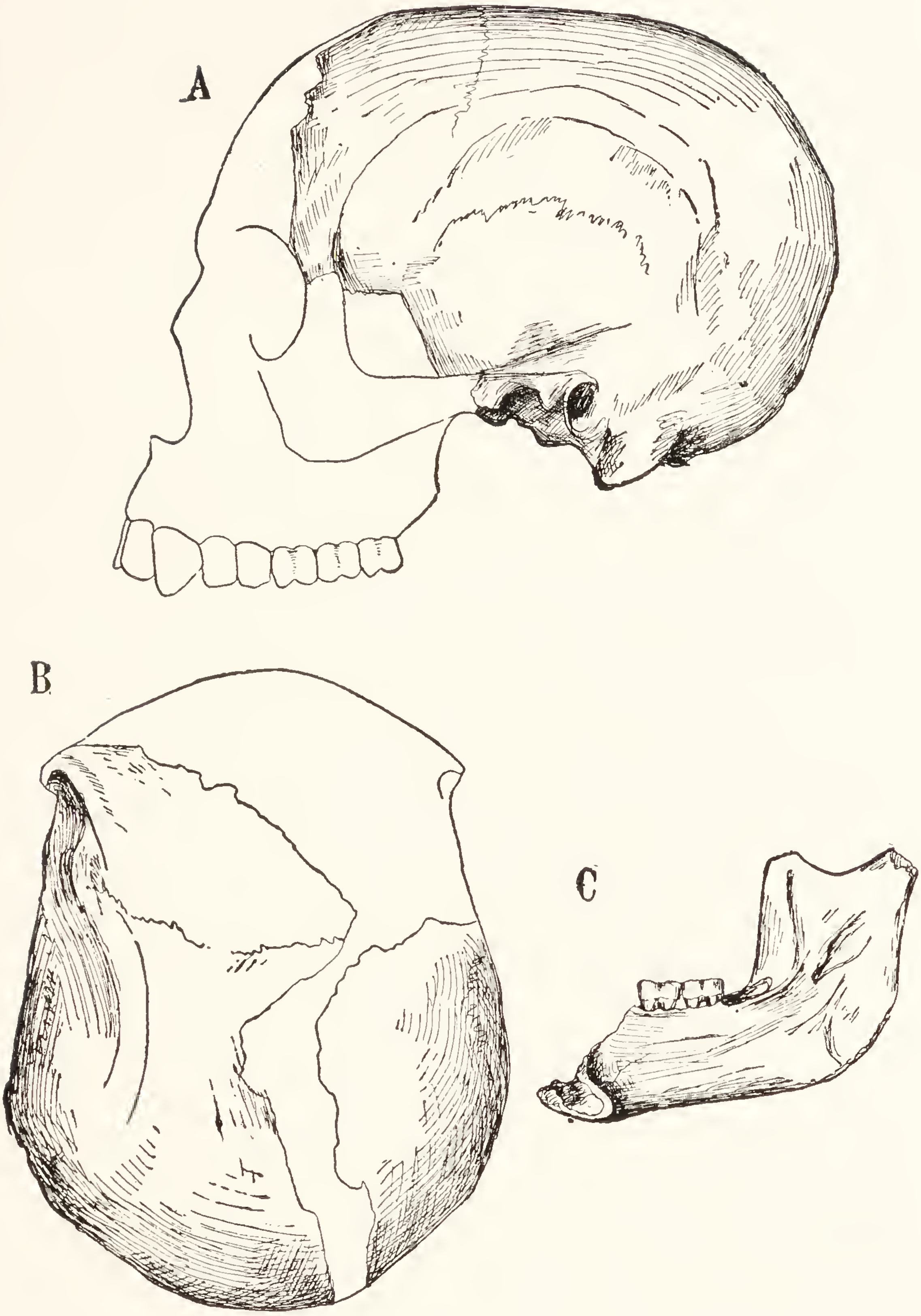


FIG. 41. The Piltdown skull, *Eoanthropus dawsoni;* from the gravel-pit at Piltdown, in Sussex, England.

A. The cranial fragment, with restoration of the missing parts, seen from the left.

B. The same, from above.

C. The mandibular half, from the inside, but without the missing tooth, which was found detached. After Smith-Woodward.

From Wilder, Man's Prehistoric Past. Courtesy of the Macmillan Co.

In a cast the two half-jaws allow a gap of scarcely a millimeter between them. The jaw-half, the right, possessed the first and second molars, besides which there was the lower right canine, which was assumed to be from the same individual. No parts of the alveolus adjacent to this tooth were found, but the tooth was set from the dental curve shown by the two molars, which were in place.

Assuming that this dental curve was correct, the position of the upper teeth could be obtained, and from this the missing face could be reconstructed with but slight liability of error, and the two nasal bones were adjusted to this in the right place.

Thus reconstructed, the "Piltdown skull" was nearly as complete and as well known as the Neanderthal, but great consternation was spread by the assertion by a leading American Mammalogist, Dr. Gerritt S. Miller, that the jaw was not that of any type of man, but plainly that of an unknown chimpanzee which he named *Pan vetus.* No such form was known, and no large anthropoid had ever been found in England, and thus this Piltdown discovery was that of two animal types, both new, but that it was an error to associate them.

The most recent investigators of the Piltdown remains, however, feel quite sure of the fact that the bones all belonged to the same individual, and that any ape-like characters of the jaw, although extremely interesting, are to be expected.

In shape this Piltdown skull is rather more like the modern species, *H. sapiens,* than is the Neandertal type. The cranial dome is decidedly higher, and the huge supraorbital tori are not indicated in the fragment of the left parietal, which, although it contains but a little strip of the orbital margin, still has enough of it to show the condition there. In short, there is a general feeling of corroborating the first name suggested to the Geological Society, *Eoanthropus dawsoni.* This means that there are not only distinct specific differences from either *Homo neandertalensis*

or *Homo heidelbergensis*, but that there are generic differences as well, and that consequently it has no right to the generic name *Homo*, but that it should be supplied with a new generic name also. In form and the slant of the face it is more like modern man than the Neandertal type, and probably also than the man of Heidelberg, but the cranial bones are extremely thick and in that respect quite unlike any of the others. The jaw, also, is generically distinct.

40. THE JAVAN APE-MAN: PITHECANTHROPUS ERECTUS. The Munich artist, Gabriel Max, widely known as the painter of a celebrated Madonna, painted a fantasy for the 60th birthday of Ernst Haeckel, the great zoölogist of the University of Jena, and presented it to him. It was the pictorial representation of a transition-form, midway between the large man-like apes and the modern species of man, *Homo sapiens*. Max was a thorough anatomist and a devoted admirer of Haeckel, and embodied in this painting the speculations of his friend, which the latter had previously described and to which he had given the name of *Pithecanthropus alalus* (the ape-man that did not talk). The painting showed a family group, consisting of a seated woman nursing a child while the father stands beside her, leaning clumsily against a tree.

While not in any way disturbing the artistry of the entire composition, the figures were posed so that they give the exact lines which are the most useful anthropometrically. The face of the woman is shown full front, the man, turned three-quarters sideway, discloses a pointed ear, while the child, with its head thrown back in a natural attitude, gives the exact view of the head from the top, the *norma verticalis*. The woman's feet furnish also the important characters of a primitive great toe, for while one foot, pressed against the ground, separates this member from the rest, still suggestive of the ape, the other foot allows the great toe to drop back under the influence of gravitation, and assumes nearly

a position as in the modern species. The hair grows very low on the forehead, and in the eyes there is a suggestion of a tear, indicating quite human emotions. The man's head suggests a somewhat triangular forehead, evidently produced by emphasizing the temporal crests as in the males of the large apes and the heavy supra-orbital tori are also ape-like. The treatment of the hair is exactly what would be expected in such a transition form. The hair from the head is prolonged down the back, with further suggestions of it over the general surface.

Haeckel's 60th birthday occurred in 1894, and by the most singular coincidence in anthropological history some remains were being unearthed at the same time in the island of Java, which corresponded in general, though not in detail, with this new famous painting. Eugene DuBois, a military surgeon attached to the Dutch Army, was requested by the Governor-General of the Dutch East Indies to undertake the collection of Holocene and Pleistocene vertebrates, and it was while engaged in this work that he made this sensational discovery. The remains (cf. Fig. 34) consisted of a skull-cap, an entire left femur and two teeth, and definitely registered the former existence of a transition form, a genuine "missing link," concerning which there had long been so much popular demand a few years before. These pieces were not actually in contact, but lay on the same level and there was no doubt that they were scattered parts of the same individual.

The skull-cap was extremely low, much lower even than was that of the Neandertal skull, and was similarly marked by projecting supra-orbital tori, much more projecting than those of the Neandertal man, but closely resembling those in the large man-like apes, especially the gibbon. From the teeth the dental curve could be ascertained, suggesting a large degree of prognathism.

The femur was not only long, and of human shape, but absolutely straight, not curved as in the Neandertal type,

proving that this being walked quite erect, as in modern man. DuBois, in searching for a name, was at once reminded of the *Pithecanthropus* described by Haeckel, and so recently painted by von Max, but he hesitated about using Haeckel's specific name *alalus*, "the one without speech," and substituted for this the name *erectus*, in other words a character of which we were certain in place of one that was hypothetical.

This Javan ape-man was thus named by its discoverer, Dr. DuBois, *Pithecanthropus erectus* and has since then held the center of interest. The anthropological world was at once divided into three camps; one of these held that it was a man, but one more ape-like than any hitherto known; a second that it was an ape, but one more man-like than any known; the third that the form was intermediate between a man and an ape.

Since then, as would be imagined, repeated search has been made in this and other localities, for further remains of *Pithecanthropus*. An extensive expedition led by the widow of Prof. Emil Selenka, previously a companion of her husband on an expedition in the East Indies, collecting embryos of the great apes, succeeded only in bringing back a single tooth from the same locality, and thought to have belonged to the same individual. Thus far this one individual remains unique, but is yet a definite proof of the former existence of a transition form. No longer now may sensational journalists speak with such humor of the "missing link." We have now a complete series of links that show man's ancestry more completely than that of any other animal form, yet the argument does not in any way depend upon this. Scientific anthropologists have never needed such missing forms, yet find great interest in all such forms when found. With some plausibility, then, we turn to Asia, and its large islands, where we may expect to find the remains of such transitional animals, not for the purpose of making copy for our sensational journals, but for completing our knowledge of the Pedigree of the Human Race.

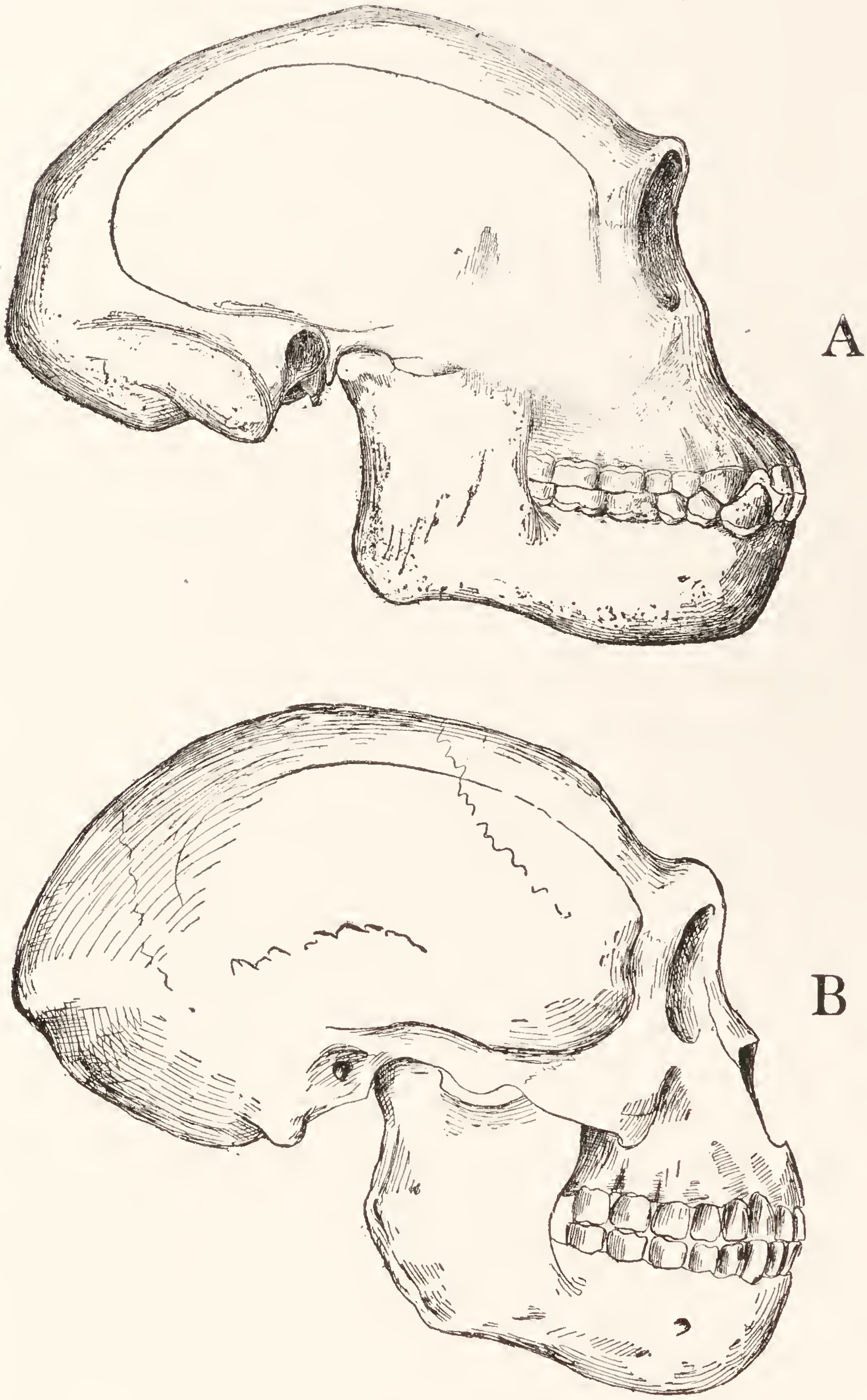


Fig. 42. A. Restoration of the skull of *Pithecanthropus erectus*, the ape-man from Java, after DuBois.

B. Hypothetical form, showing skull outlines intermediate between those of *Pithecanthropus*, as reconstructed by DuBois, and the La Chapelle-aux-Saints, to which has been attached the jaw of *Homo heidelbergensis*.

From Wilder, Man's Prehistoric Past. Courtesy of the Macmillan Co.

40A. AUSTRALOPITHECUS AFRICANUS. This newest of the transition forms was discovered in February, 1925, in a limestone quarry near Taungs in Bechuanaland, South Africa, by Professor Raymond Dart of Johannesburg. The actual dis-

FIG. 42½. *Australopithecus africanus,* discovered near Taungs, Bechuanaland in Feb. 1925. After Broom. Courtesy of the American Museum of Natural History.

covery was made by the manager of the Lime Company, Mr. A. F. Campbell, and consisted of a brain-cast to which was attached the larger part of a skull, including the complete face. He turned this over to Professor R. B. Young, a geological

colleague of Professor Dart, through whom the specimen came into the hands of the latter. Professor Dart made a cast of this and sent it to his former teacher in London, Dr. Elliot Smith, who exhibited it at the meeting of the Zoölogical Society at Wembley, June 9th last. Dr. Smith prepared a paper on "The Cradle of Mankind" and published it in the Italian journal, *Scientia.* He also sent the first manuscript copy of this paper to the present author, who is thus enabled to add some details of this remarkable creature. The skull is that of a child, corresponding to that of a human child of six years, or an ape child of three or four. Eyebrow ridges are absent. The jaw is not so prominent as in apes. In the form and size of the jaws and teeth it resembles the human type, also in the proportions of the nose and orbits, "and especially the proportions of the face as a whole and its harmonious relations to the skull. . . . All afford definite, if individually slight, indications of the beginning of the process of refinement of the features that is an essential part of the transformation of an ape into a human being." The brain is not so large as that of the largest known gorilla, but as this individual was still very young, the brain was not at its full growth, and thus it may be said that the brain of the adult *Australopithecus* was larger than that of the gorilla.

Dr. Smith recalls Charles Darwin's prophecy that Africa is likely to prove the place of origin of the Human Race, since it is the native land of those animals which are the nearest akin to Man of any now living.

41. The Single Tooth from Nebraska, Hesperopithecus Haroldcooki. A single tooth, the upper left second molar, worn as if through glacial grinding, has recently been brought to light in Nebraska and gives us hope of eventually learning the entire story of man's beginning. This discovery was made near the beginning of the year 1922, associated with remains of *Pliohippus,* and other

Pliocene animals. Judging from the tooth alone the animal seems to have been about halfway between *Pithecanthropus* and the man of the present day, or perhaps better between *Pithecanthropus* and the man of the Neandertal type, and is assumed to represent a very early migrant from the Old World, passing over land bridges, which then quite possibly existed. It thus revives again a hope, long since abandoned, that the human stem may have had its beginning in the New World.

42. The Oldest Known Men of the Present Species, Homo Sapiens.[1] The recent study of Prehistory, a study largely based upon the implements left in the soil by early man, and the efficient aid furnished by surface geology, have divided up the past time during which there have been found any traces of human or semi-human activity into definite Ages and Periods, named in general from the geographical names of the localities where the typical deposits have been found. These have been dated from the glacial advances and retreats of the Ice Age, during the last part of which Man arose, so that, while definite dates in years cannot be assigned to the remains found, assignment to a certain Period can be definitely given.

Men of the modern species, *Homo sapiens*, are known, at present, as far back as the Aurignacian period of the Middle Paleolithic, back of which, although there are several long Periods indicated by flints, and other artifacts, there are few bones extant. The Mousterian Period was just before the Aurignacian, and in this skulls and skeletons of the Neandertal species are now fairly well known. The two skeletons of the cavern of Spy, that of the Chapelle-aux-Saints, and the boy of Le Moustier, to mention only a few, and the type at the Neandertal itself, were all of this latter species

[1] For the entire chronology of prehistoric times see the present author's work, "Man's Prehistoric Past," Macmillan, 1923.

(*Homo neandertalensis*), and were specifically distinct from *Homo sapiens;* but at the Aurignacian time-level of the Middle Paleolithic, we find, at least in two different localities, the remains of true men, quite of the modern type. One of these localities was at Les Eyzies, on the river Vezère, a tributary of the Dordogne, in Southern France, the exact site being at Cro-Magnon. Here, a few minutes from the village of Les Eyzies, there is a small "rock-shelter," or "abri-sur-roche," and here were found in 1868 remains of four skeletons. As has been already said, their period was Aurignacian, the next Period subsequent to the Mousterian, and can be dated approximately at the end of the "Wurm" Ice, the last of the four great Glacial advances. In years, if one wishes to be so pedantically exact, we may say that the retreat of the Wurm Ice was about 25,000 years before our era, and going back still further, to the first appearance of this same Wurm Ice, we must reckon at least another 25,000 years; this enormous Period of time contained the two prehistoric Periods of the Aurignacian, and back of that the Mousterian, two of the Periods of the Middle Paleolithic.

The other locality where were found remains of the earliest of the present species was at and about Mentone, in Southern France, across the Italian border adjacent, and in the principality of Monaco, neither France nor Italy, but between the two. Here the limestone of the Riviera is filled with small caves, and in these caves are favorite sites for excavations by the prehistorians. These deposits are of the Mousterian and Aurignacian Periods, of the same time as the similar deposits of Les Eyzies, and here some dozen skeletons of men of the "Cro-Magnon Race" have been excavated, and are now preserved in the local museum at Mentone. With these were found some well-preserved skeletons of a different race, also *Homo sapiens,* but possessing certain negroid characters, indicating that at this early time not only were men of the modern species present in the world, but were already differentiated into several

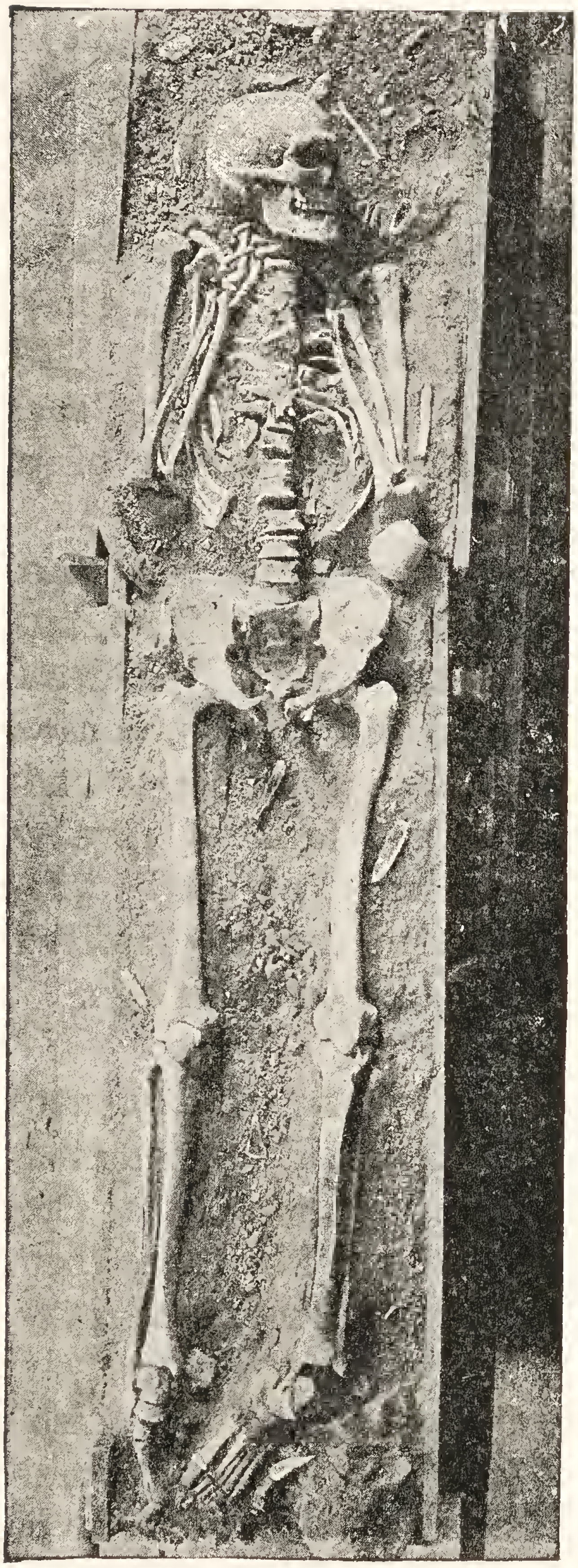


FIG. 43. Cro-Magnon type of skeleton from Baussè-Rousse, after Verneau, in L'Anthropologie. From Wilder, Man's Prehistoric Past. Courtesy of the Macmillan Co.

races. This race has been named the "Grimaldi Race," after the family name of the Prince of Monaco, who made the discovery.

Who these Cro-Magnon people may have been no one can

tell, but it has been surmised that they were migrants, either from Africa or from Asia. In favor of the former is the fact that the skulls are all dolichocephalic, as are the inhabitants of Africa at the present day.

In stature they were large, or even very large, measuring from 1800-1900 mm. (5 ft. 10 in. to 6 ft. 4 in.) with an average male stature of 1870 mm. (6 ft. 1 in.). Shells of *Dentalium* and others (*Nassa*), with perforations, suggest a plentiful bodily decoration, after the manner of primitive people at the present time.

We cannot know at present who these Cro-Magnon people were, nor where they came from, but it is significant that afterwards we find no more Neandertal skeletons, and that the appearance of the Cro-Magnons was at about the same time as the appearance of a new and vastly superior form of art, both in the form of cave paintings and of carvings on bone and ivory, an art that reached its zenith in the Magdalenian Period, the second after the Aurignacian, and terminating about 18,000 years ago.

43. Other Ancient Skulls and Skeletons (European). Aside from the two definite European sites of skeletons of early man of the present species, (1) the Cro-Magnon region and (2) the Riviera about Mentone, there are numerous noteworthy bones, mainly skulls and jaws, which have a similar antiquity, but whose status, relative to the others, is not definitely determined. All are Paleolithic in age and are usually found associated with crude flints, and with the bones and teeth of other Quaternary mammals. They occur in river-drift gravels, glacial loess, and other glacial deposits, and are therefore ancient, but it is necessary to subject them to the most modern methods of anthropometry in order to give them a position relative to the rest upon which to base any definite value in the study of human pedigrees.

How this is done belongs to a special branch of science, for which there is no opportunity given in this book, yet a

few of the most vital comparisons may be given, and from these sufficient data may be obtained to put these remains in approximately the place usually assigned to them at present.

Perhaps the most important of these coming from the British Isles, aside from the Piltdown skull, which belongs in quite another category, and probably does not even belong to the Genus *Homo*, is the "Galley Hill" skull which was found by two amateurs, Elliott and Heys, in 1888.

The remains included nearly a complete skeleton, which was "found in situ, at a depth of more than eight feet, in Pleistocene high-level river drift, which there rises from ninety to one hundred feet above the Thames."[1] This was placed by many authorities, together with the skull of Brüx, in the "Galley Hill group," *Homo sapiens*, indeed, but of a lower grade than any recent men, excepting the Australians.

The skull of Brüx was found in Bohemia in 1871, and was first shown before the Anthropological Society of Vienna, in December of that year. It was found in diluvial sand, in association with a fine Paleolithic hand-axe, or "coup-de poing." A quite similar skull was found in Brünn in Moravia in 1891 by Makowsky, and as it had in all probability been an interment, the data concerning its position would have no meaning. What is interesting is that it was found in the city itself (Max-Joseph Strasse) and that the same anthropologist had a few years previous found another skull, which, although afterwards proven to be of modern type, probably Neolithic, created much interest at the time and was known as "Brünn I." Consequently the one found later in the city, and often confounded with "Brünn I" has become known as "Brünn II." These three skulls, Galley Hill, Brüx, and Brünn II, were doubtless all Paleolithic. They were all extremely dolichocephalic.

[1] G. Frederick Wright, Origin and Antiquity of Man, Oberlin, 1912, p. 297.

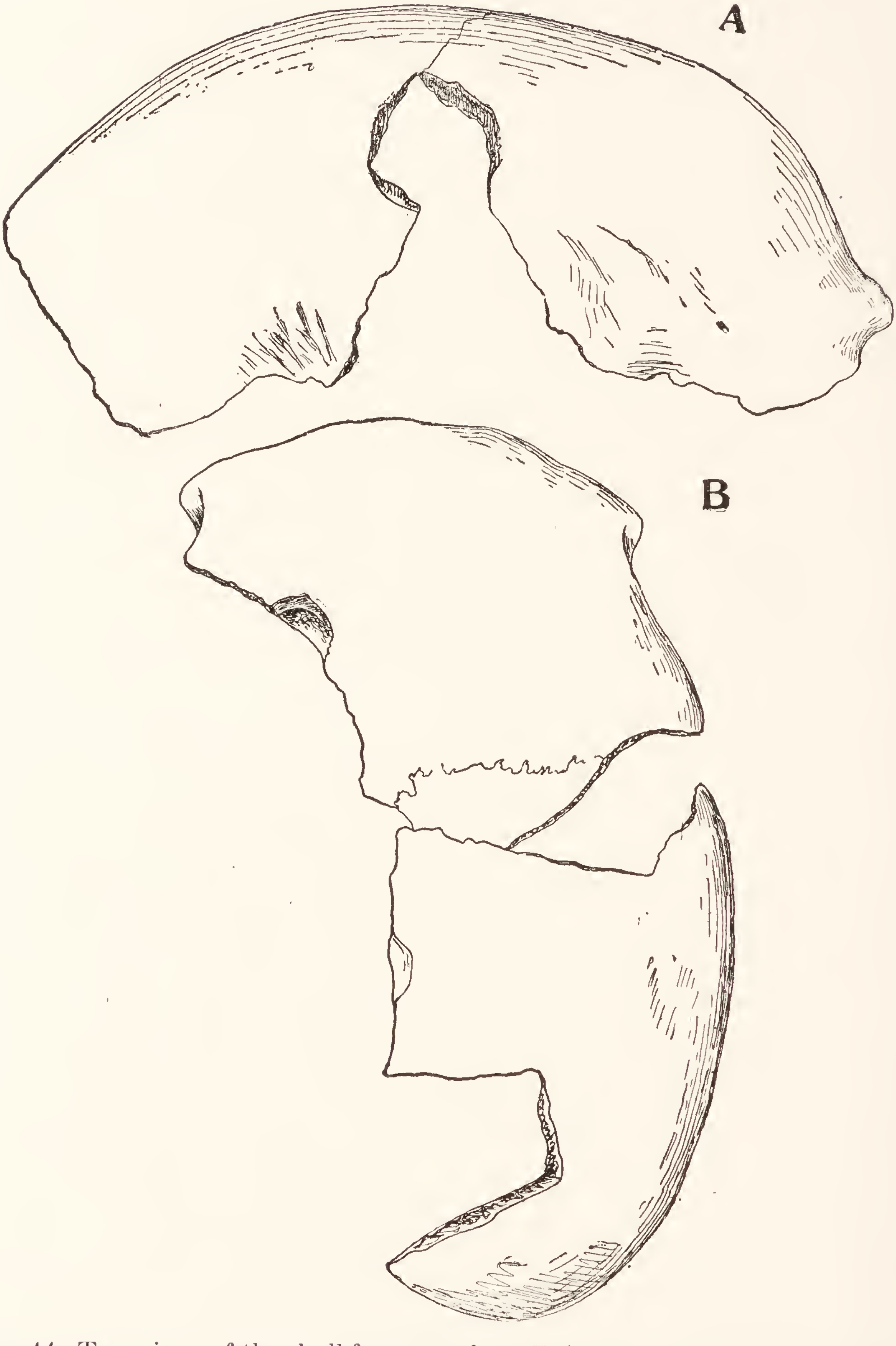


Fig. 44. Two views of the skull fragment from Egisheim, near Colmar. From Schwalbe, after Faudel. From Wilder, Man's Prehistoric Past. Courtesy of the Macmillan Co.

Another similar skull is that found at Egisheim, near Colmar, in Alsace. It also was found in glacial loess, in association with the bones of Quaternary animals. This was found in 1865, a little earlier than the others, but judging from what is known concerning the excavations, and the state of preservation of the actual specimens, nothing excavated much earlier is to be expected, as careful methods of removal, even when specimens are found, are extremely modern. Brünn II, for instance, was carelessly stepped on by a workman, and this unlucky step destroyed the jaw, and a large part of the face. The Egisheim is described as "very fragmentary," and lacks face and jaw. The Galley Hill skull, according to drawings, seems to be in a similar condition, save that here the jaw is saved. The perfect condition of the existing parts, combined with the casual fragments of information concerning the methods of removal, lead us to think that, under proper care, the bones might have been removed more successfully.

Still, although under over-civilized surroundings it is easy to criticize past attempts, some experience with the skeletons of local Indians, which have not been buried more than a few centuries, and where often the first discovery was made by a plow, lead us to be very lenient towards the often poor results of excavations of such fragile material as bones, especially those of the face.

A vast number of other excavated bones are known, some of which are probably of Neolithic date, and therefore not ancient in comparison to those truly Quaternary, yet as these Neolithic bones are from 10,000 to 15,000 years of age, or older, they may seem to some sufficiently ancient. Such old skulls, like those of Tilbury, Denise, Sligo, Podbaba, Marcilly, Brechamps, Olmo, indicate by their names the interest in the Prehistoric possessed by all nations at the present time, and there are few of our larger European Museums but what possess certain ancient skulls of at least Neolithic age.

44. Ancient Skulls and Skeletons in America. It is becoming more and more the opinion that the Americas were originally peopled from the Eastern Hemisphere, presumably from Asia, across Behring Strait, and that therefore ancient human remains of Quaternary date are not to be expected. Still, in our present knowledge, this is by no means a definite conclusion, and later discoveries may, at any time, prove the presence of Quaternary man in America, or that of still older, transition forms. This is indicated by *Hesperopithecus*, for, although only a single tooth, it is a definite indîcation of the presence of such an animal, and causes professional scientists to talk of a possible American origin for the Hominidae (in our sense) instead of one in the Eastern Hemisphere, that has thus far been taken for granted. Still the great majority of American human bones found thus far have been shown to be, or are considered, Indians, and except in the Trenton gravels there is little support for the former existence of glacial man in America. The Lansing skeleton, the Nebraska man, the Calâveras skull, have been cast aside, one by one; supposed ancient skulls in South America have met a similar fate at the hands of Hrdlička, and we have little better to expect from Vigo, Florida, the location of the latest "prehistoric" American. We constantly expect great things from Asia and Africa; Europe is continually yielding much concerning the men of Glacial times, and we may at any time make discoveries in America that will revolutionize our conceptions. If we ever do find indubitable indications of the former existence of glacial man in America, we must not seek to avoid seeing it, or try to suppress the evidence, or even discourage the attempts to get it, because of our preconceived opinions.

45. Methods of Examination and Comparison: the Calvarial Height. The first consideration to be noticed in the comparison of skulls is that they are to be viewed in the same way, and at exactly the same aspects. For

purposes of comparison a skull may be considered something like a cube or box, and thus has six aspects or sides from which it may be viewed; the top, bottom, front, back, and two sides, the two last like each other but reversed. For technical study these six aspects, or *norms*, must be exactly oriented in accordance with a definite anthropological plane, the *Frankfurt Horizontal*, internationally established at an anthropological Congress in 1884 at a meeting in that city, after having been previously proposed in 1877 at Munich. This Frankfurt Horizontal is that of a plane passed through the highest point of the two auditory meatuses (*porion*) and the lowest point of the margin of the two orbits (*orbiculare*) and the six norms are in direct relationship to that. The *norma frontalis* (front) and the *norma occipitalis* (back), are perpendicular to this Frankfurt Horizontal; so are the two lateral norms, *normae laterales sinistra et dextra*. The aspect from above and below, *norma verticalis* and *norma basilaris*, are parallel to this, and at right angles to the other norms.

Viewing a skull from either lateral norm, we get a dead profile and a mechanically made tracing of this, the *median craniogram*, is, perhaps, the most valuable single picture that can be taken. In such a drawing, or in a skull, as seen from the side, the height of the cranium as a whole, and the shape of the forehead, are the first characteristics to be noticed, and the need is at once felt of expressing these characters by measurement, or at least in some other way than by words or phrases like "low cranium" or "retreating forehead." It is for this purpose that the measurement, *cranial height*, was devised by Schwalbe, which gives us the means of measuring accurately the exact cranial height of a given skull, and also, by means of the *cranial height index*, to compare directly skulls of different size.

A *glabella-inion line* is first drawn on a median craniogram, and upon this line the longest possible perpendicular is erected. This is the *calvarial height line*, "Kalottenhöhe,"

and the *calvarial height index* may be obtained by dividing this length by that of the glabella-inion, after the usual manner of indices. It thus expresses the calvarial height in terms of the glabella-inion line, or as a percentage of this latter. It can be compared directly in the case of two skulls one of which is large and the other small, as they are not the actual figures but a percentage of them.

Studied in this way the calvarial-height index of all known

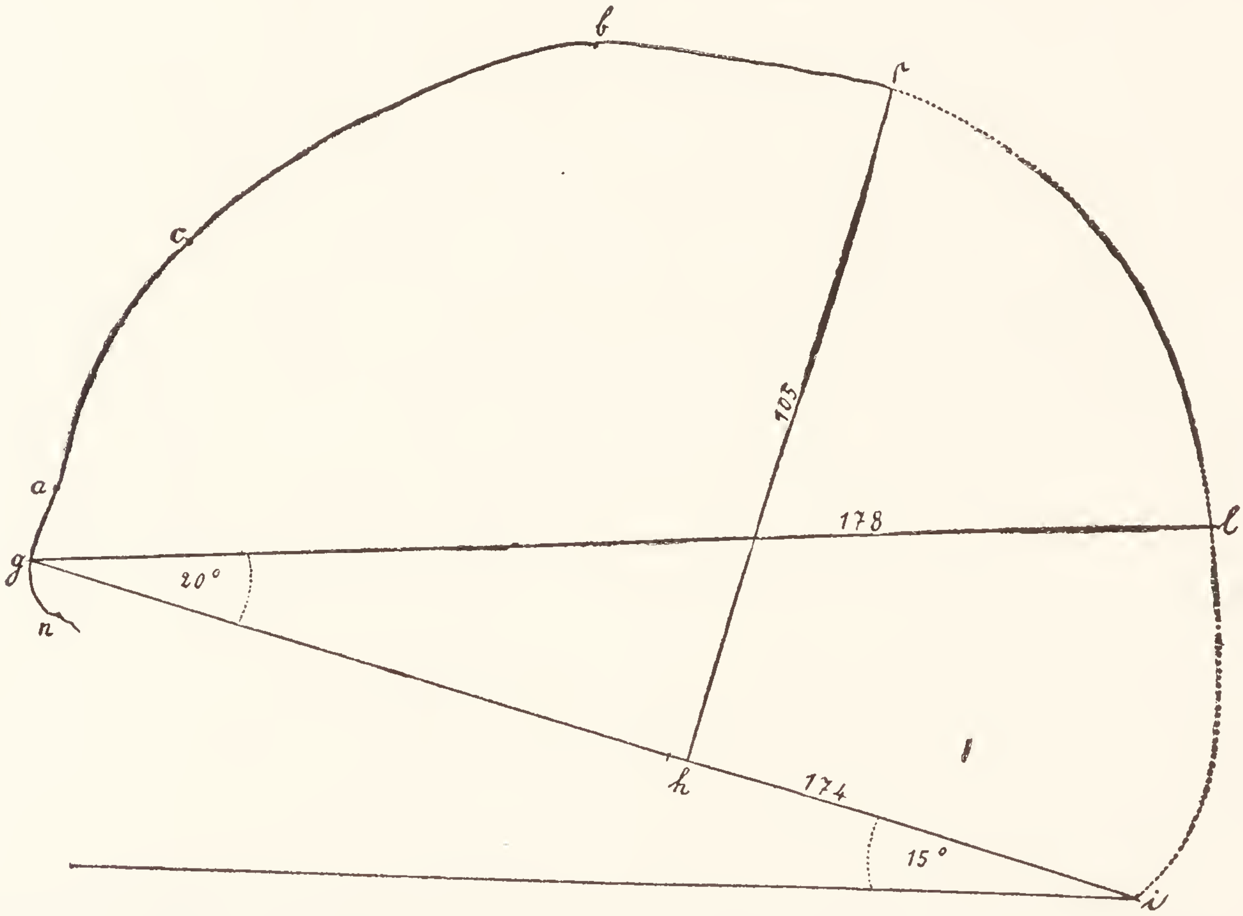


Fig. 45. Median craniogram showing the Calvarial Height. The glabella-inion length line (g-i) is first drawn, and upon this line the longest possible perpendicular falling within the skull contour is erected (p-h). The glabella-inion line is placed at an angle of 20° to the glabella-lambda line (g-l), and is set at 15° to the Frankfurt Horizontal, or rather its parallel, and the figure is thus oriented. After Schwalbe.

skulls of the Neandertal type is less than that of *Homo sapiens*.

The calvarial-height index of the typical Neandertal skull is but 42.9, that of Gibraltar is 45.4 while the skulls of Galley Hill, Brüx, and Brünn II respectively are 48.2, 47.6 and 51.2, approaching the calvarial-height index of the present-day Australian, which averages 56.5. We have

thus in the calvarial-height, and especially in the calvarial-height index a definite means for comparing directly an important characteristic of ancient with modern skulls.

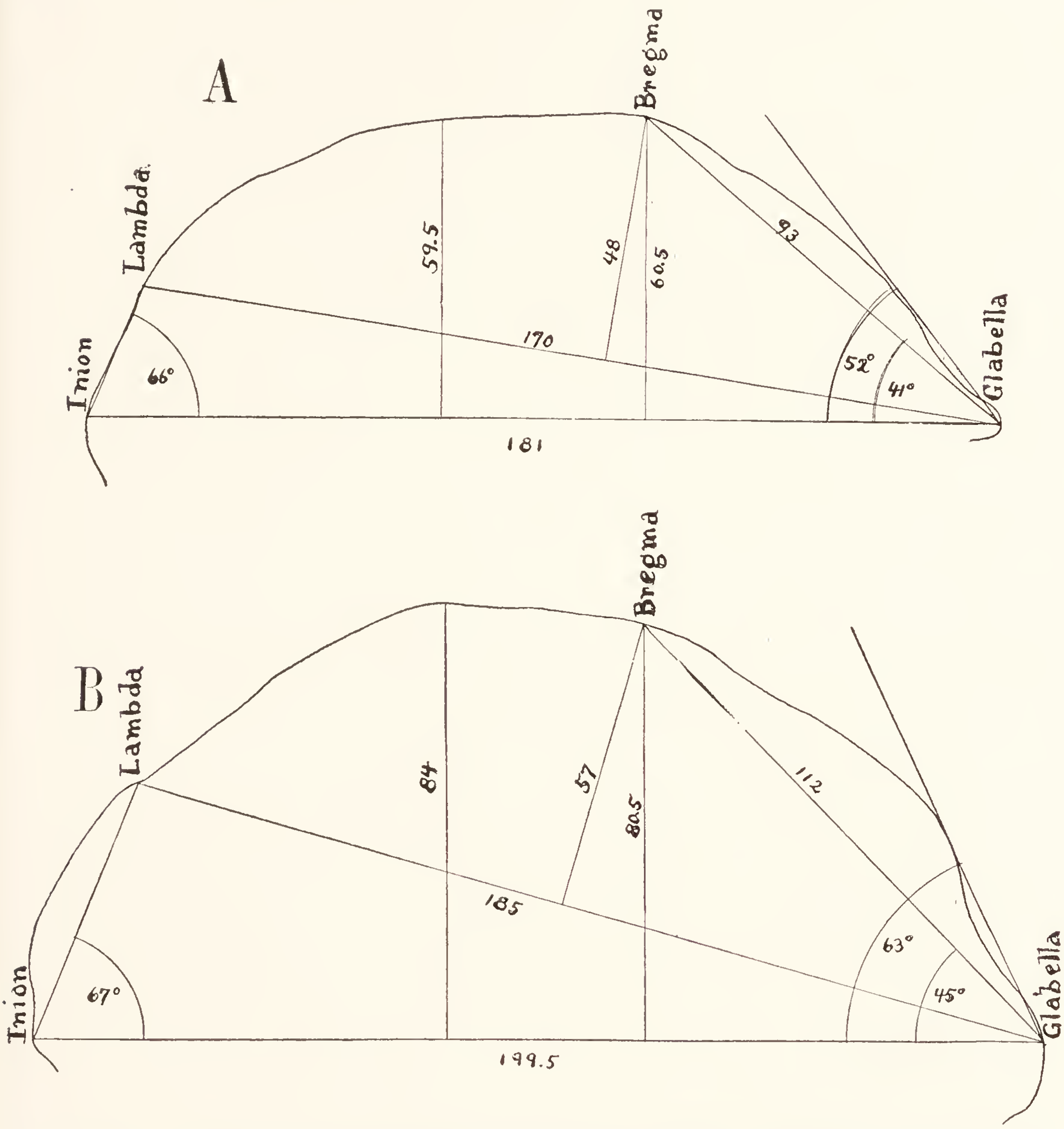


Fig. 46. A. Skull of Pithecanthropus erectus; median craniogram drawn and measured by Klaatsch.
B. Median craniogram of the original skull from the Neandertal valley; drawn and measured by Klaatsch.

46. Methods of Examination and Comparison: the Bregma and Lambda Angles. These angles, also obtained from the median craniogram, are based on the principle that an expansion of the brain is accompanied by an uplifting of the frontal and occipital bones, and indicates

directly the extent to which this is accomplished in a given skull. These angular measurements were first devised by Schwalbe for the study and comparison of the cranial

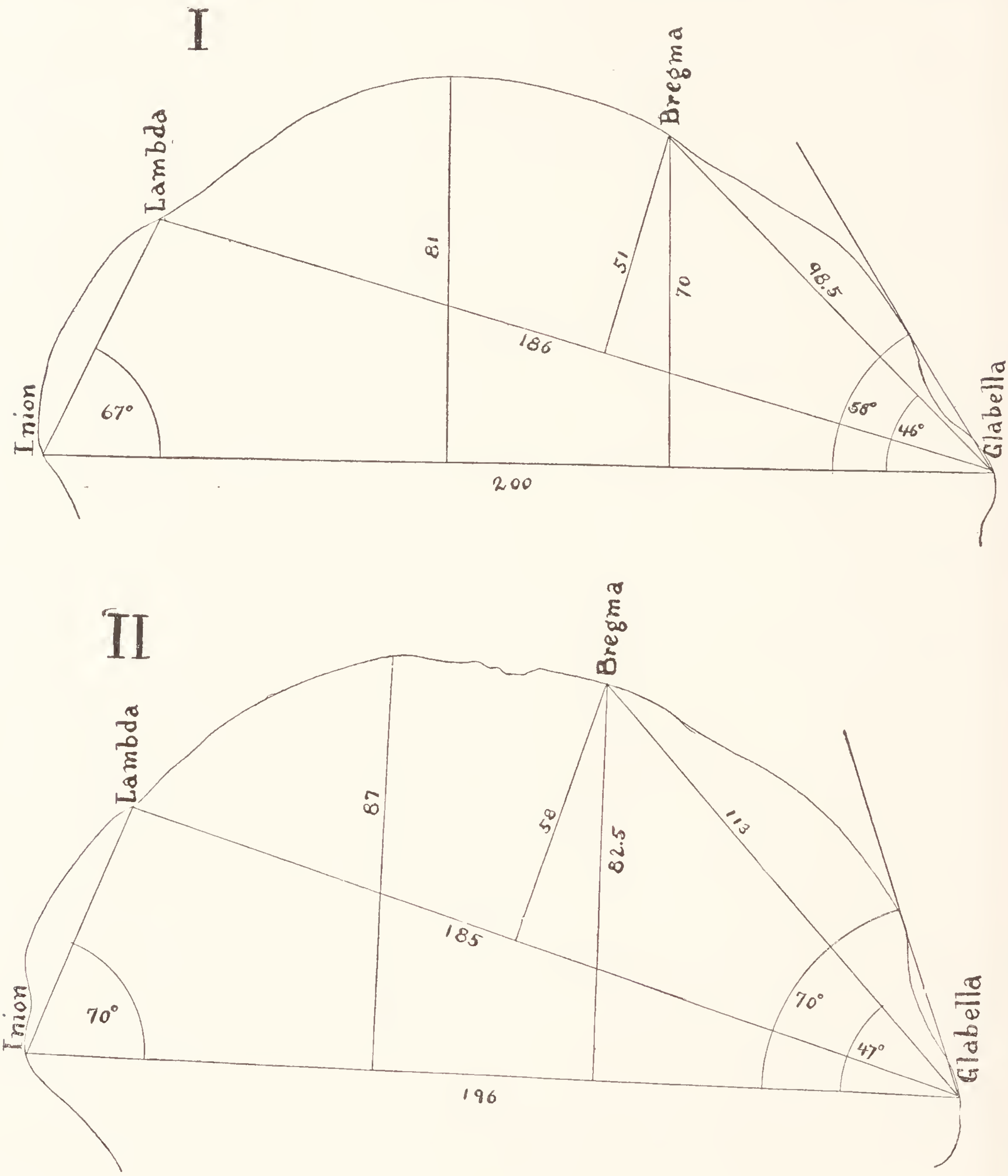


Fig. 47. I. Skull of Spy I; II. Skull of Spy II; median craniogram drawn and measured by Klaatsch in both diagrams.

vault of *Pithecanthropus*, and have been since proven to be of great use in the study of all hominid skulls, especially those of doubtful position. As Schwalbe first used them,

they were based upon the glabella-inion line, and the two angles in question were formed by drawing straight lines from the two ends of this through the bregma and lambda respectively.

The angles thus formed by these new lines with the glabella-inion line were called the *bregma* and *lambda angles* respectively. These angles are easily measured by a projector, especially a transparent one. The bregma angle, which proves to be of the greatest use, runs from 54° to 60° in the native Australian, but in the skulls of *Homo neanderthalensis* has a range of from 44° to 51°, and 41° in *Pithecanthropus.* In Brünn II it is 54°, in Brüx it is only 51.5°, and in Galley Hill it is 52° and in Cro-Magnon 54°, all suggesting a very low type of the present species.

A third important angle, also drawn on a median craniogram, is formed by the glabella-inion line and a line drawn from the anterior end of it, tangent to the profile outline of the frontal bone. This, called the *frontal angle,* suggests the facial angle of Camper, but is much more precise. Although only 52° in *Pithecanthropus* and 63° in the Neandertal skull, it rises from 63° to 73° in the Gibraltar skull, and in Galley Hill and Cro-Magnon it rises to 82° and 83° respectively.

Another important curve is the *median frontal curve.* An included angle is drawn by drawing first a chord between the cerebral part of this, and the arc formed by the surface of the frontal bone itself, the longest perpendicular possible is drawn within these two, and the two ends of the chord connected with the upper end of this. The angle formed is measured in the usual way, and indicates the amount of bulging of the frontal bone. The larger the angle the flatter the forehead, the smaller the angle the more bulging.

By some such methods as those given here, the comparison of skulls may be made, and the place in the pedigree of a given skull determined. Even in a case in which the parts obtained are mere fragments, they give often valuable indications

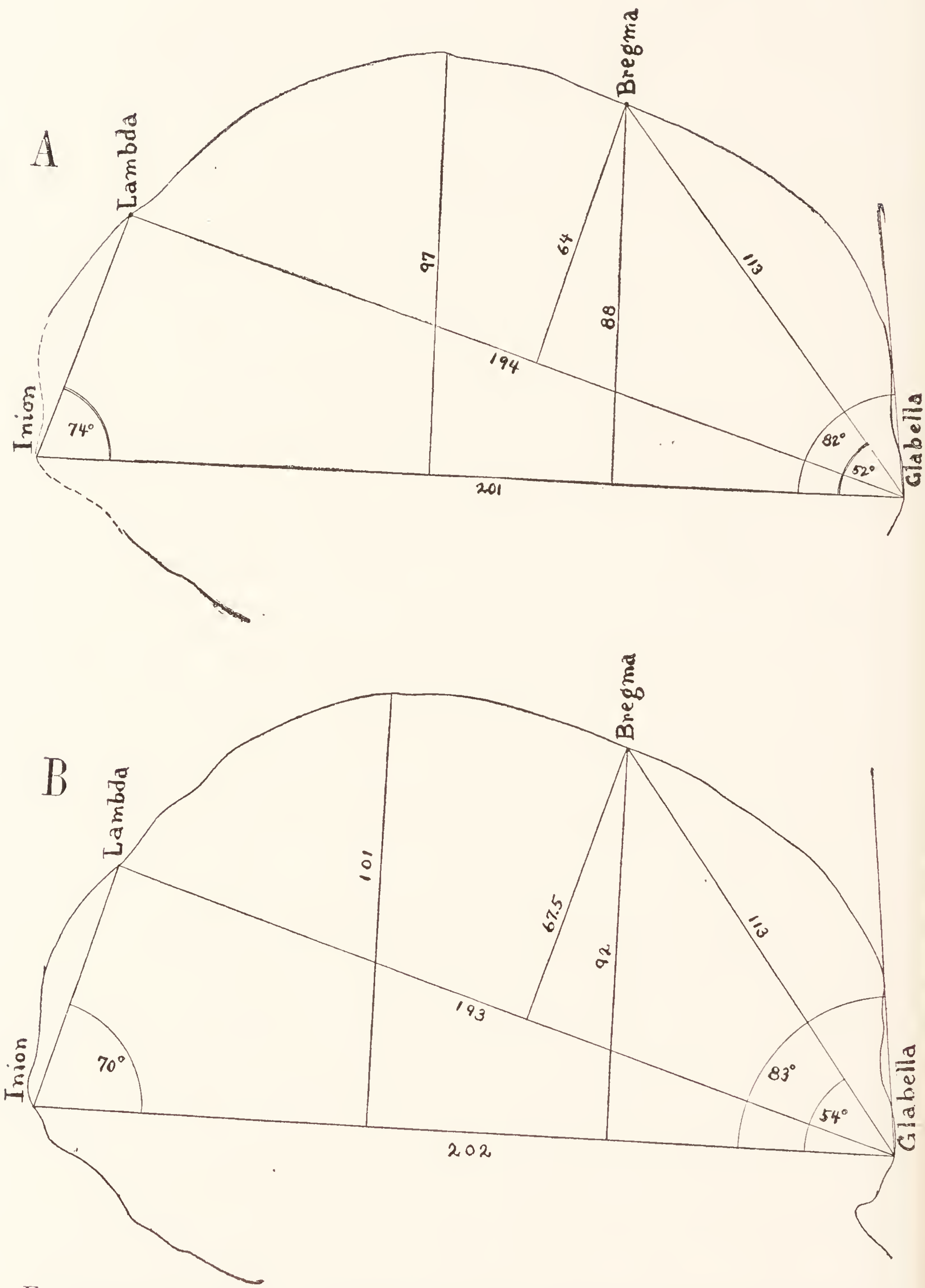


FIG. 48. A. Skull from Galley Hill; median craniogram drawn and measured by Klaatsch.

B. Skull of the "Old Man of Cro-Magnon"; median craniogram drawn and measured by Klaatsch.

concerning the characteristics of the skull examined, and its place in the series.

47. Detailed Study of the Unterlesece Skull: the Site and the Circumstances of the Discovery.[1] What may be done with a definite find of this nature, and the actual application of the foregoing principles, is well illustrated by the discovery of a skull fragment in a cave in Jugo-Slavia, obtained by the present author in 1911, and worked up by him by the use of the principles of modern anthropometry. As an illustration of these methods it makes little difference that the skull was evidently Neolithic, and not older than ten or twelve thousand years. The method was the same as though it had been as important as the skull of Galley Hill, and the fragment was broken in such a way that it seemed at first to definitely possess Neandertal characteristics, which would have given it great value in a theoretical discussion concerning the origin of present-day man. In any event, every such fragment ought to be subjected to an equally thorough study, especially when, like this one, data from the site were not obtainable.

Unterlesece is the name found at that time on local Austrian maps, and given to a small village of Slavic inhabitants, situated then within the bounds of Austria, about two miles from the important railroad junction of Divača. Since the war, as a result of the setting apart of Jugo-Slavia as an independent country, it is probable that this village is known as Podlesece, certainly not any longer as

[1] Lieut. Mühlhofer, the actual discoverer of the Unterlesece Skull, was, for some time, a co-worker in the caves about Nabresina, near Trieste, in company with a man named Martin and the author and his wife. Later on, while the author was in Bosnia, Mühlhofer excavated the grotto in Unterlesece and found the skull. This was given to the author upon his return to Nabresina, and eventually it was deposited in the Museum at Smith College, where it now is. Martin fell in Serbia with a bullet through his head, and the last heard of Mühlhofer was that of a wounded prisoner at Irkutsk. Should these lines ever reach him it may please him that his "Unterlesece Skull" served a useful purpose.

"Unterleseče." Within this village there exists a low cavern or grotto in the limestone of the region, opening up from the lowest point in a slightly sunken field into which the local farmers had for a generation thrown their loose stones, as a convenient way of getting rid of them. Lieut. Franz Mühlhofer of the Austrian army, and the President of a

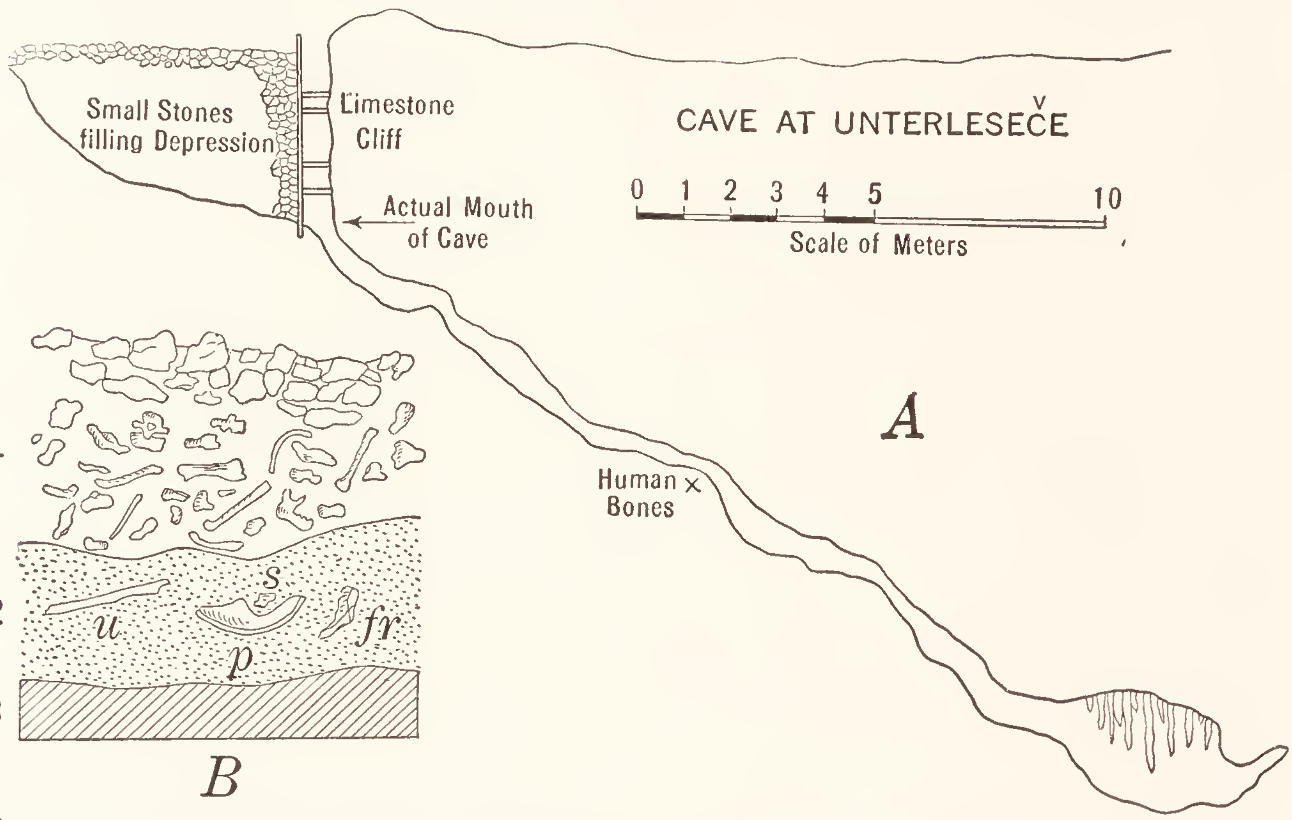


FIG. 49. A. Length section of the grotto at Unterleseče, where was found the skull described in the text. It was evidently Neolithic.

B. Section of the floor of the Unterleseče grotto at the place where the skull was found.

1. Upper layer, containing the débris from the roof. In this were found bones of ass, horse, pig, and sheep, also human bones. These bones included those of an arm and upper body, also a jaw, with the teeth worn off smooth, as in primitive peoples.

2. Lower layer of fine clay, in which were found the bones of the human skull described in the text. With these was found a small Neolithic shard.

3. Limestone in which the grotto had been cut.

speleological society in Trieste, whose object was to explore thoroughly the numerous caverns in the vicinity, discovered this cave whose whereabouts he learned from conversation with the inhabitants of the village, especially one Herr Prhavč, the landlord of the local inn, and had had the stones removed as a preliminary to a thorough examination; he also provided the vertical shaft, about ten feet in length, with wooden planking to make it more accessible.

He penetrated to the bottom, where it expanded abruptly into a terminal chamber, the size of an ordinary room, thickly hung with heavy stalactites. (Fig. 49, A.) Upon a shelf of rock within this chamber was found a perfect Neolithic vase, still standing where it had been left at least eight thousand years before by the original owner. Elsewhere the cavern, like a very low drain, extended at a gentle slope up to the mouth, a distance of perhaps 25 or 30 meters, so low that it did not allow one to even sit up straight, except in the terminal chamber, where one might stand by fitting his head between the stalactites. The outer terminus extended vertically upwards, for about ten feet, down which one could climb by means of the planks set across this shaft. This grotto was thus much like a man-hole for taking in the surface water, and it was evident that from time to time through the ages, the bones and teeth of occasional animals had been washed in and deposited in the pockets along the bottom. Quantities of the bones of horses, donkeys, sheep, pigs and so on were found in these places, and in a somewhat deeper pocket were found two layers, each containing human bones. Those of the upper layer included almost an entire skeleton of the upper half of a large man except the skull, but with the jaw, and the teeth had been worn flat, precisely like those of Indians in this country. In the lower layer, directly underneath, was found the skull in question, in two pieces, a right ulna, and a fragment of a Neolithic shard. (Fig. 49, B.) This skull was undoubtedly Neolithic or older, judging from the location; it was evidently older than the jaw with the ground-down teeth, but in such a cave, never used for a dwelling, and with the objects introduced by water, there was no means of asserting definitely that any object was actually Neolithic, or even as old as that.

48. The Unterlesečе Skull: Orientation and Restoration. Firmly imbedded in the clay of the lower layer, a

position in which time would have no appreciable effect, even reckoned by thousands of years as units, there were found two fragments of a human skull which, when cleaned, were found to be the adjacent portions of the same skull, and to fit perfectly. Fastened together, they formed the greater part of a cranial roof, with rather heavy brow-ridges, and it

Fig. 50. A. Top view of the Unterlesečе skull.

was broken in such a way along the edges that, when held horizontally as it naturally would be, it gave the impression of an unusually low head and a very sloping forehead. When first found it gave the impression that it actually possessed neandertaloid characteristics, and we felt some hope that in this we might have a transition form between the neandertal

type and *H. sapiens*, and only a thorough study of the fragment showed that it was plainly a typical *H. sapiens*, without any such characters. The first step towards such a study consisted of a complete restoration of the parts that were present, and that was done by first restoring on one side the parts given on the other, that is, ascertaining the median line and then completing the symmetry. This was easily done by means of plastilena, and resulted in a nearly complete skull-roof, lacking only the posterior part, which could be easily sup-

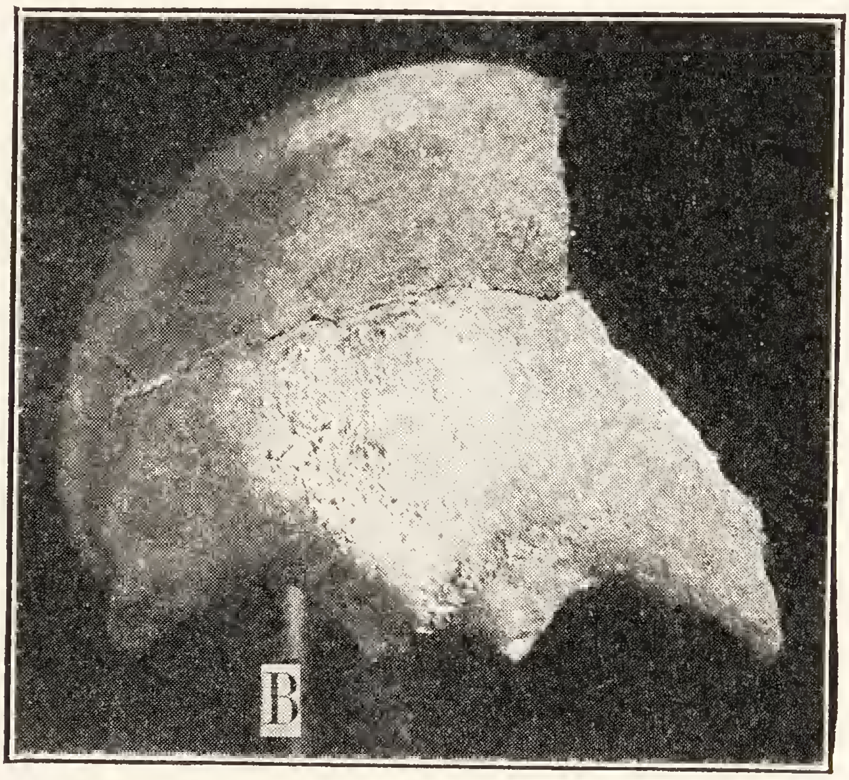


Fig. 50 (continued). B. Front view of the Unterlesečе skull, showing the heavy brow-ridges.

plied by the adjacent parts without much chance of error. (Figs. 51, B, and 52.) The occipital part of the median diagram was a little uncertain, and in drawing this, two possibilities were indicated, giving as many possibilities for the position of the important points, *lambda* and *inion*. Still, this restoration could be quite definitely oriented, by the relations of these two points, whether extended or not, in a normal *sapiens* skull. The angle formed by the two lines, glabella-lambda and glabella-inion, is approximately 20°, and that formed by the glabella-inion line, and one passing through the inion, parallel to the Frankfurt Horizontal is 15°. (Fig. 45, Schwalbe.) Thus the

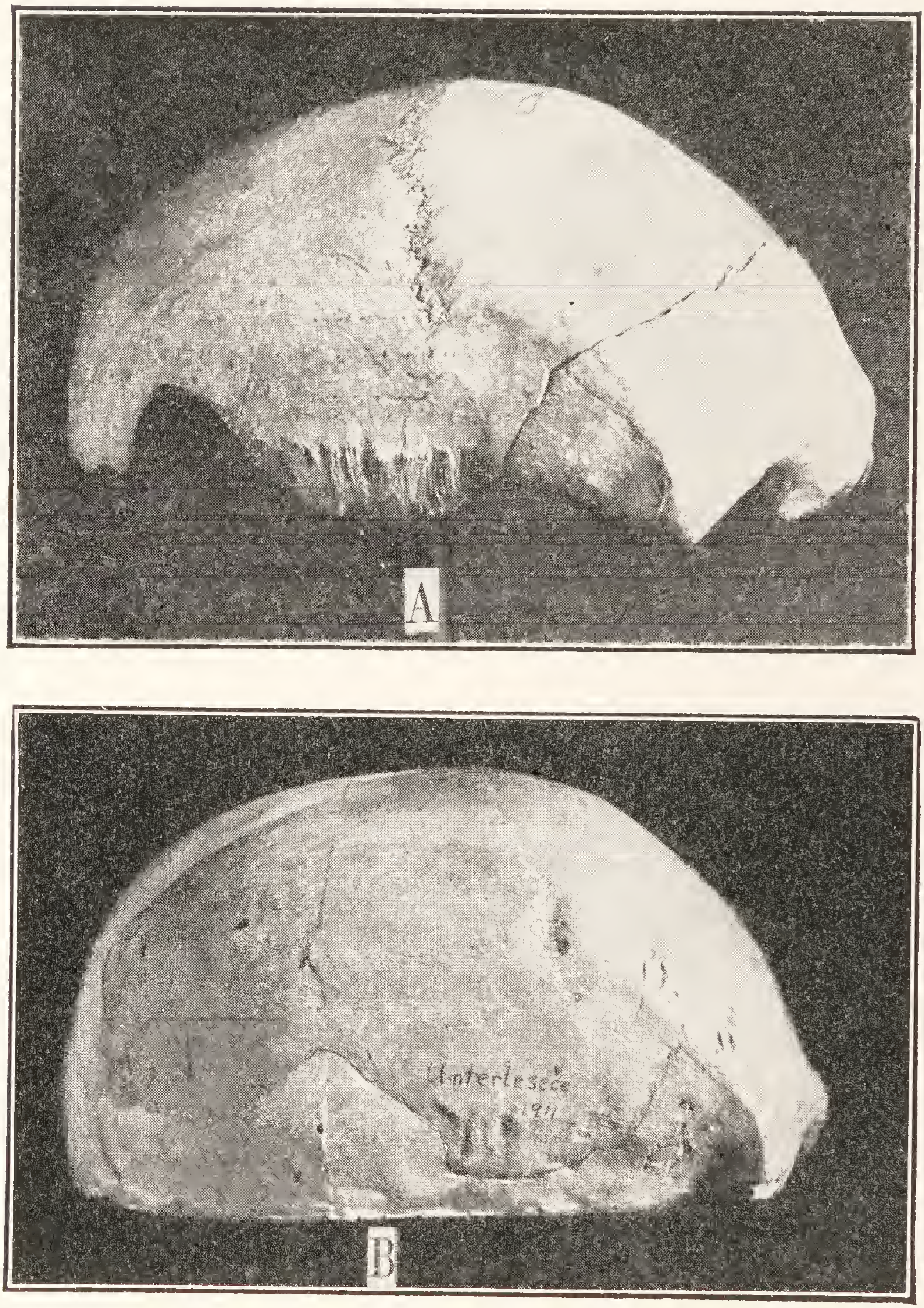


Fig. 51. A. Side view of the Unterlesece skull, with the two pieces fitted together.
B. Restored Unterlesece skull; side view.

median curve, as well as the restoration, can be set up on this essential horizon, and the slant of the forehead, as well as the cranial height, be ascertained. (Fig. 53.)

When correctly placed the low character of the cranial vault of our specimen entirely disappears, and it is seen to be a normally shaped skull, just what would be expected of a Neolithic man, which the surrounding circumstances and

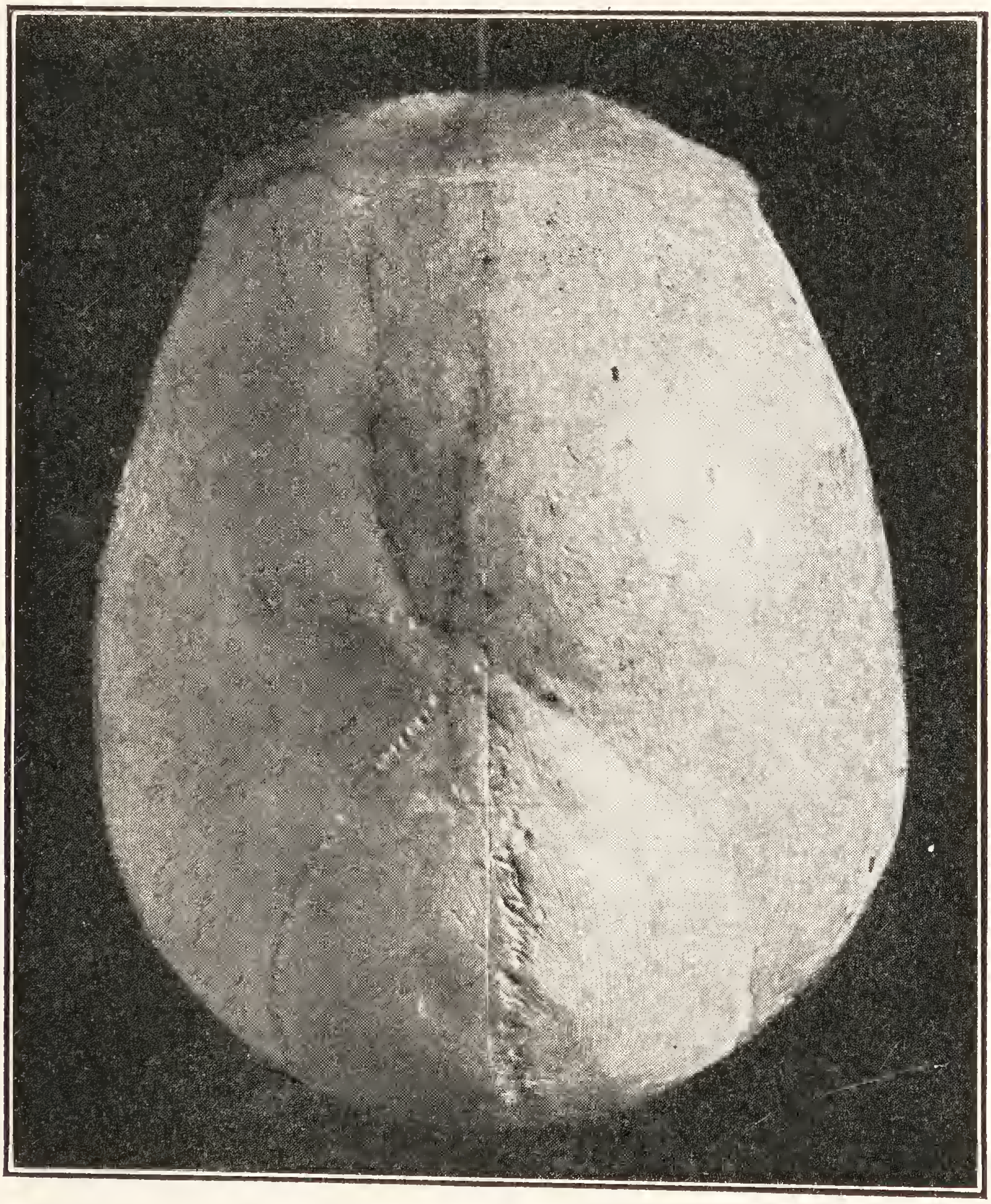


FIG. 52. Restoration of the Unterlesečе skull from above.

position seemed to indicate. The brow-ridges, although heavy, are not heavier than is frequently met with in a modern male skull, and are indicative simply of a strong emphasis on the sex characters, by no means unusual.

Thus, by the proper study of such a fragment, it

may be definitely compared, and its position accurately ascertained.

49. FURTHER MEASUREMENT OF THE UNTERLESEČE SKULL. The details of many of the essential measurements, taken from this fragment or from the restoration based upon it, are best considered from a study of the median craniogram.

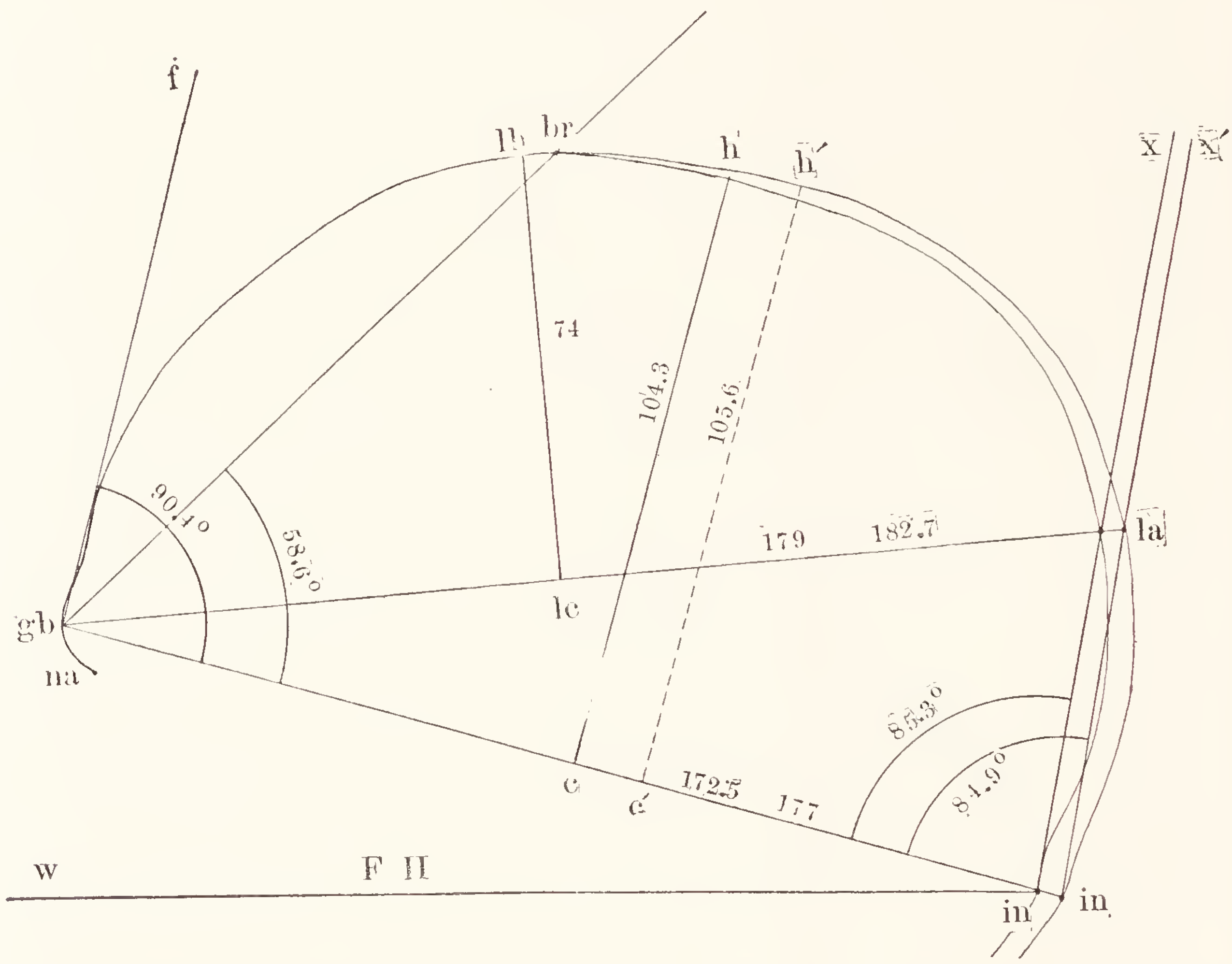


FIG. 53. Median craniogram of the Unterlesече skull, showing the essential proportions. The Calvarial Height is 104.3, using one restoration, and 105.6, using the other, both quite within the range of modern men. The skull is set up with reference to the glabella-inion line, and shows a normal contour.

(Fig. 53.) The calvarial height, that of the highest perpendicular that can be erected upon the glabella-inion line, and within the limits of the cranial profile, measures 104.3 mm., or, if we use the outer limit of the restoration, 105.6 mm., and these, reduced to indices, as percentages of the glabella-inion line, 172.5 (or 177) equals 60.47 or 59.32, a fair calvarial-height index for a normal human skull of the modern species.

The frontal angle, the same with using either restoration, f-gb-in, is 90.4°, again a good size for a modern man, and the bregma angle, br-gb-in, is 58.6°. The lambda angle, either gb-in-x or gb-in-x′ in accordance with which contour was taken, is 85.3 or 84.9. The angle la-gb-in set at 20° and that of gb-in-w at 15° orients the whole diagram correctly and fixes the Frankfurt Horizontal parallel to the line FH, disposing forever of the impression so strong at first view of the fragment that the forehead was unusually sloping.

Numerous other angles and measurement might also be taken from the same diagram, as well as from other parts of the fragment, but more are not essential to prove its position, and we may definitely classify the Unterleseče fragment as that of *Homo sapiens*, in all probability Neolithic.

CHAPTER IV.

TRACING THE PEDIGREE

50. Principles of General Morphology as Applied to the Primates. As in every other group of animals the members of the group of Primates express the varying adaptations to the various environments to which they have become adapted, and these adaptations are largely expressed in the increase or reduction in the usual proportions of the parts. Thus the more typical representatives of a group are those in which there are no marked exaggerations or reductions in the characteristic organs, but all parts express the ideas of the group in a harmonious manner. Thus, of the five skulls shown in the accompanying Figure (Fig. 54), the one in the center, a *Semnopithecus* (a), is far more typical than any one of the four by which it is surrounded, since it has avoided the exaggerations which are so conspicuous in the others. By comparing these with the central figure it appears at once that they are all exaggerated and in the four cardinal directions, forward, backward, above, and below. The one on the right (b) has prolonged the snout in adaptation to some food-habit, or method of defence, which has rendered this exaggeration necessary; the one below (c) has similarly exaggerated the contour of the head downwards, in this case in connection with the formation of a resonance chamber for the voice; the one on the left (d) has prolonged the back of the skull, perhaps for some mechanical reason connected with the use of the neck muscles; and the one above (e) has raised the cranial vault for the reception of an exaggerated cerebrum. From the strict morphological standpoint these four exaggerations are of equal value, and express alike simply an extension of the head in a given direction in connection with some form of adaptation, but it so happens that the parts chosen in the various cases for

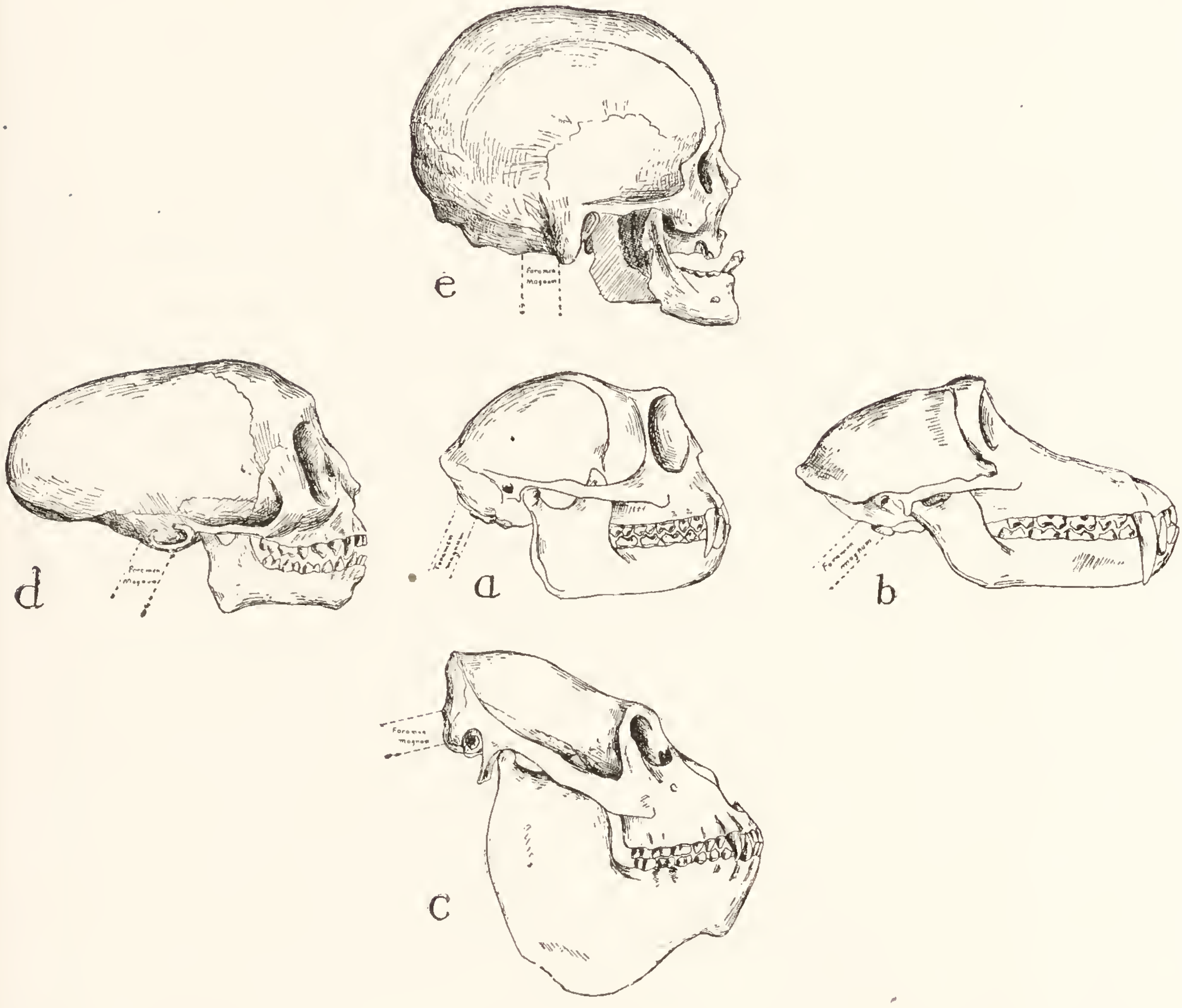


FIG. 54. Comparison of Primate skulls, showing the modifications in different directions within the limits of the Order. Beginning with the one in the middle, which may be taken as one with well-balanced proportions, an excessive development may occur in any of the four directions, as shown above, below, in front or behind, by the four skulls surrounding the central one. All are taken from actual cases but are brought to the same proportions for easier comparison. The skull in the middle is a *Semnopithecus*, an East Indian monkey; the one on the left, showing an extreme development of the hinder part of the skull, is a *Chrysothrix* from South America; the one below is *Alouatta*, one of the Howling Monkeys, from Central America; the one on the right is *Papio*, a dog-faced baboon, and the one above is a man, *Homo sapiens*, and happens to be the skull of Immanuel Kant.

The figure of Chrysothrix is borrowed from Weber, that of Kant is taken from Wiedersheim; the others are drawn from specimens in the Smith College Museum.

exaggeration are very different physiologically, and while the prolongation forward makes only a dog-headed baboon, and the one below a howling monkey, the prolongation upward may result, as here, in an Immanuel Kant.

Every morphological feature, be it exaggeration or reduction, fusion or separation, has its direct cause in the habitual environment of the species considered, the constant influence of which is continually felt by the organism, and responded to by modifications of structure. That the general environment of the early Primates was an arboreal one is beyond question, and the human body still shows countless relations and proportions that have been acquired during a life in the trees and have been retained through the conservative action of heredity. With the chimpanzee and the gorilla, Man has followed along the line of those prosperous Primates whose increased size rendered a continual dwelling among the tree boughs inconvenient, and who thus gradually adapted themselves to the surface of the ground, and to the more or less erect position conditioned by it. How, and to what degree, he has been successful in this, in comparison with his nearest animal allies, it will be the task of the present chapter to consider.

51. Bodily Proportions of the Living Hominidae. While the actual proportions of the parts of a single body may be easily shown by means of measurements, the relative proportions between bodies of different sizes and shapes may be set forth only by comparing the actual measurements of each body with one another in the same body, or, usually with one of them taken as a standard. Thus if in a given specimen of a gibbon the arm, by actual measurement, has a total length of 70 cm. to the finger tips, while in a chimpanzee the arm measures 80 cm., it cannot be said that the latter animal has the longer arm proportionately, because it is a much larger animal; if, however, some single measurement, as the length of the vertebral column, be taken as a

standard and the above figures be compared with this in each case, the resulting figures express, not actual measurements, but percentages which are directly comparable. For example, assume in the above case that the gibbon used for comparison has a vertebral column of 40 cm., and the chimpanzee one of 80; a comparison of the 70 cm. of the gibbon's arm with the 40 of its vertebral column gives a proportionate figure of 1.75, while in the chimpanzee the ratio of 80 (the arm length) to 60 (the length of the vertebral column) is but 1.33.[1] In common language the arm of the gibbon in the example is three-fourths as long again as the vertebral column, while in the chimpanzee it is only one-third longer; that is, the gibbon's arm, although actually shorter, is proportionately much longer.

In the above illustration the case was an imaginary one and the figures, although approximately correct, do not rest upon actual measurements; the following table, however, expresses a series of actual proportions obtained from measurements made directly upon the articulated skeleton of Man and his three nearest living allies. As in the example given, the standard used is the length of the vertebral column, measured from the base of the skull to the end of the coccyx; furthermore, the terms "arm" and "leg" refer to the limb as far as the wrist or ankle only, and do not include the hand or foot. The proportionate values of an entire limb can be obtained by adding the figures of arm and hand, or leg and foot, as in the lower lines of the table.

TABLE I. Limb Proportions of the Hominidae (after Huxley).

	Man (European)	Chimpanzee	Gorilla	Orang-utan
Arm	80	96	115	122
Leg	117	90	96	89
Hand	26	43	36	48
Foot	35	39	41	52
Arm+hand	106	139	151	170
Leg+foot	152	129	137	141

[1] This method of expressing proportions, the employment of two different measures, and the reduction of one to a decimal of the other, taken as a standard,

From this Table may be deduced the following points:—

1. The length of the arm progresses in the order of arrangement, that of Man being the shortest, that of the orang-utan the longest; the arm of the latter (122) is more than half again as long as in Man (80).
2. In length of leg, on the other hand, that of Man is very much the longest; in the others the length is nearly the same (89, 90, 96), but little over two-thirds that of Man.
3. In the comparison of arm and leg the chimpanzee has the best proportion, with the two of nearly equal length (90 and 96). The orang-utan and Man are nearly reversed in regard to the relative length of arm and leg (117:80 and 89:122); in each animal the length of one set of limbs is much exaggerated.
4. In Man the hand is much shorter than the foot; in the others the two are more nearly equal, especially in the orang-utan; in the chimpanzee the hand is actually the longer of the two.
5. Of all parts considered the length of the foot is nearer equal in all four animals; that of Man, chimpanzee and gorilla differ but six parts in a hundred (35, 39, 41). In the orang-utan, as in the case of its arms and hands, the foot (52) is very much longer than in any of the rest, being 11 points beyond the next longest, that of the gorilla.
6. In comparing the total length of limb, Man's arm, including the hand (106), is much shorter than in any of the others, being only about two-thirds the length of the next shortest, that of the chimpanzee (139). In the leg the difference is the other way, when compared with the chimpanzee and gorilla, as was to be expected; but in the orang-utan, the enormous length of the foot proves a nearly complete compensation and gives it a total length of 141, as compared with the 152 of man.

This Table may be graphically represented to the eye by putting it in diagrammatic form, as in the accompanying

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is one constantly used in anthropometric measurements involving linear measures, since by this means a given linear measure may be expressed as a value, or ratio, which may be directly compared, regardless of actual size. This ratio (written without the decimal point) is termed an *index*, and usually, though not always, expresses the lesser of the two measurements compared.

Figure, the lines of which are carefully measured and represent the exact values of the figures given. By this such proportionate differences as that of the arms and legs in the orang-utan and Man are strikingly apparent.[1]

52. Actual Measurements of the Living Hominidae. As all simian apes are capable of standing and walking erect their stature is a matter of some interest, although the comparison gives an advantage to Man, with his abnormally long legs, and is rather unfair to the others, with their short ones. In actual standing height, the series is as follows, given in millimeters:—

TABLE II. Standing Height of the Hominidae.

Hylobates lar (representative of the smaller gibbons)	600–700 mm.
Syndactylus syndactylus (si-amang)	1000
Pongo pygmacus (orang)	1200–1400
Pan chimpanse (chimpanzee)	1300–1500
Homo sapiens (African pigmies, and other very small people)	1450–1530
Homo sapiens (medium to large; averages)	1650–1750
Gorilla gorilla	1700–2000

For a general idea of the actual size of the larger simians a few measurements will suffice. Alfred Russell Wallace, whose study of the orang-utan extended over several years, and furnished one of the earliest reliable accounts of the animal, took the measurements of seventeen freshly killed orang-utans of the Borneo race.[2] He found that the adult males "only varied from 4 *feet* 1 *inch* to 4 *feet* 2 *inches* in height, measured fairly to the heel," but that the span of the arms, owing to their prodigious length, measured from

[1] For a recent exhaustive study of the proportions of body and limbs in the Primates cf. Mollison; Die Körperproportionen der Primaten. Morphol. Jahrb. Bd. 42, 1910, pp. 79–304. The proportions here treated, together with many others, are determined with the greatest accuracy from measurements carried out upon the bodies of a large number of individuals; the work includes also all groups of the Anthropoidea.

[2] Wallace, A. R., The Malay Archipelago, chapter IV.

7 *feet* 2 *inches* to 7 *feet* 8 *inches*. These rather conservative figures correspond well with the measurements of twenty-five specimens collected by Schlegel and Müller,[1] although other investigators present larger figures. It is undoubtedly true that all of these large simian apes give the hunter an impression of huge proportions, which are not corroborated by

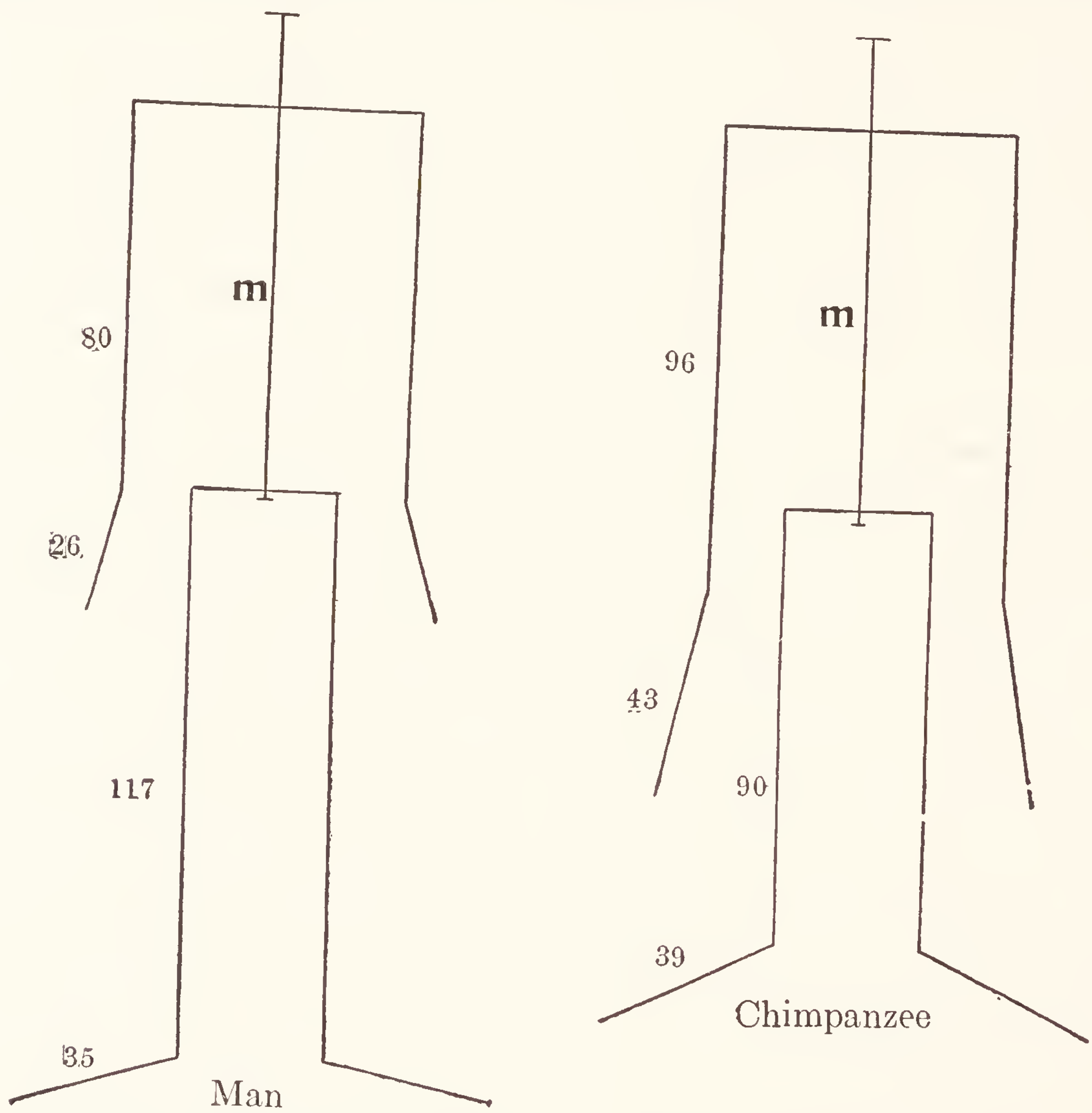

Fig. 55. Diagram showing the bodily proportions of the four higher Hominid Genera.

a careful measurement. Thus Wallace recounts the killing of a Sumatran orang-utan concerning which "the captain and crew who killed this animal declared, that when alive he exceeded the tallest man, and looked so gigantic, that they thought he was 7 feet high; but that when he was killed and lay upon the ground, they found he was only

[1] Schlegel & Müller, Verhandelingen over de natuurlijke geschiedenis der Nederlandsche overzeesche Besittingen. 1839–1845.

about 6 feet." That some of the illusion lasted through this rough field measurement is shown by the figures taken from this identical animal, when he was placed as a specimen in the Calcutta museum, which showed him to be a specimen, "by no means one of the largest size," and only about 4 feet in height.

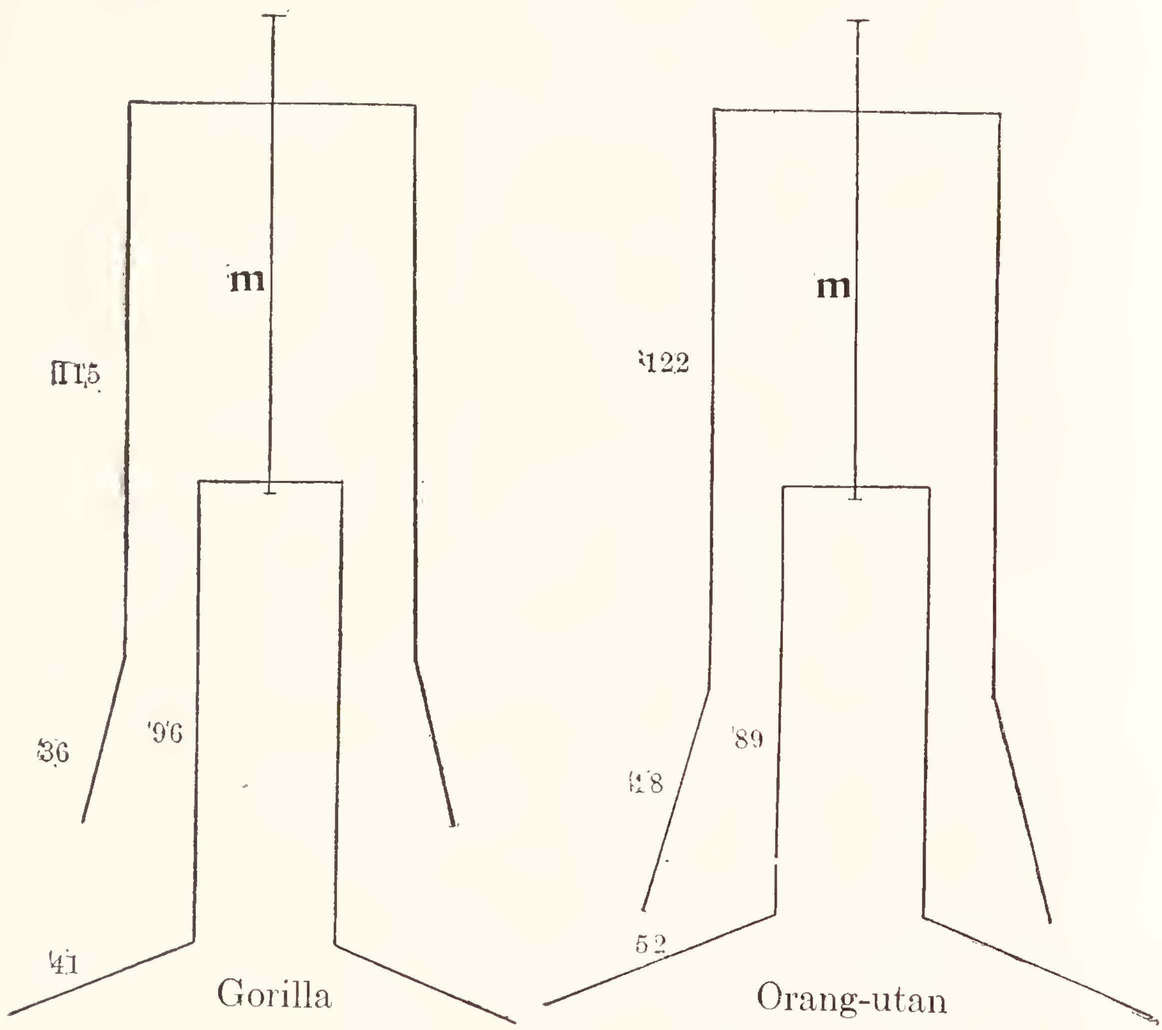

Fig. 55 (continued).

With regard to the gorilla a series of careful measurements, collected from various sources by Meyer in 1863,[1] will be of value, although they were all from stuffed specimens in the museums of Paris, London, Vienna, and Lübeck. In this the total lengths (i. e. height) of three large males were 1650, 1670, and 1750 mm., and that of a female was 1400 mm. The arm length, from the point of the shoulder (*acromion*) to the tip of the longest finger (III) ran from 900 to 1000 mm., and the span of the arms of a large male

[1] Meyer, Der Gorilla, mit Berücksichtigung des Unterschiedes zwischen Menschen und Affen. Denkschr. Offenbacher Ver. für Naturkunds. Offenbach, 1863.

in Paris was 2180 mm. The length of the leg in two males was 700 and 740 mm., and in a female 650. The girth of the body is very large; measured close under the arms it was 1290 and 1370 mm. in two males, and 1025 in a female.

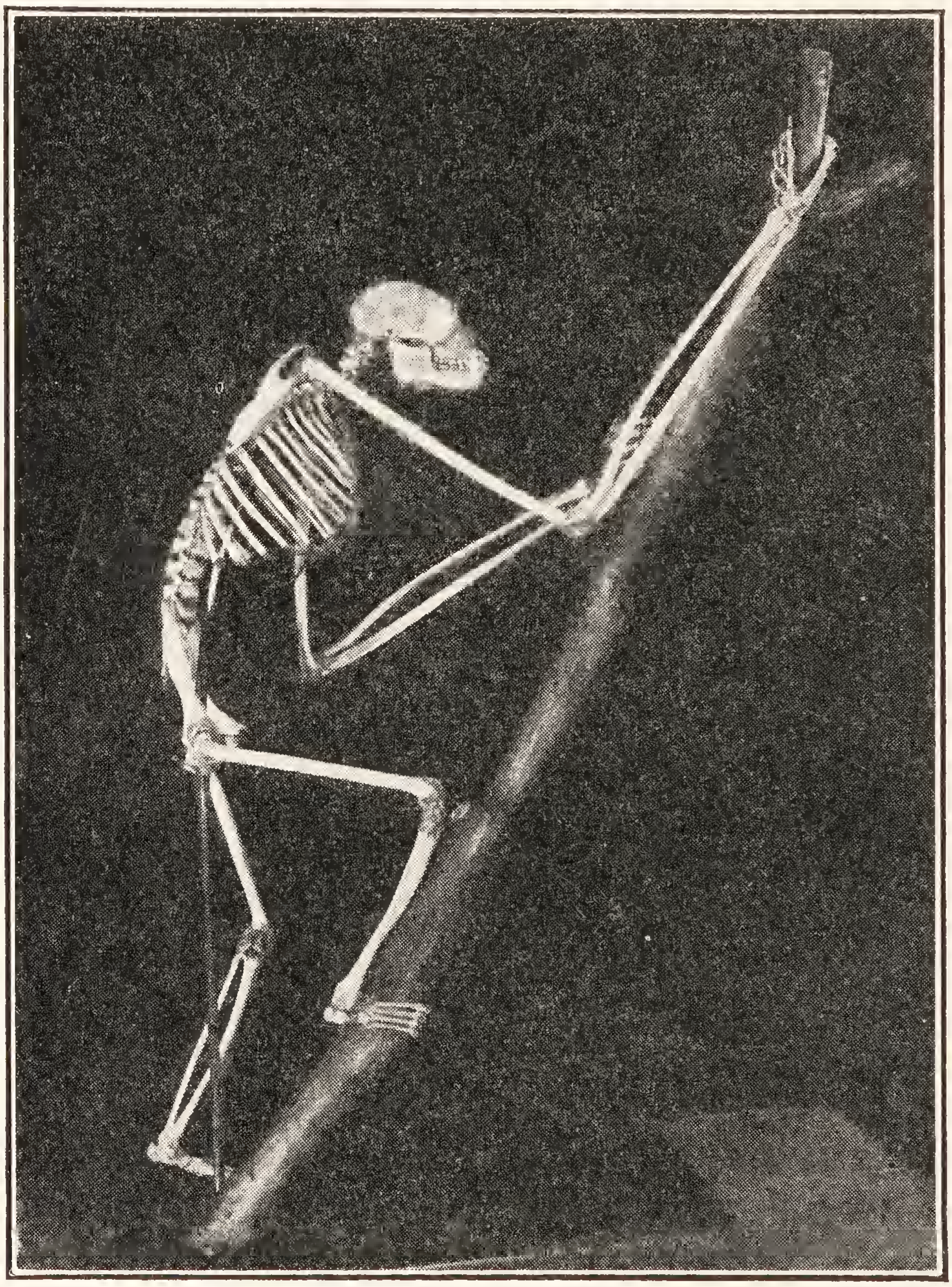

FIG. 56. *Syndactylus syndactylus,* the Long-armed Gibbon, from Smith College Museum.

Lower down, in the region of the floating ribs, the girth is still greater, owing to the expanded paunch, the result of innutritious food. For this the figures are 1350 mm. for the first male and 1225 for the female. The breadth across the shoulders in a male specimen was 1200 mm. In a large male (a Paris specimen) the girth of the upper arm was 380 mm.,

and that of the forearm 360. In the same the leg, at its origin, had a girth of 630 mm., in the middle of the thigh 560, and around the calf 350. The vertical girth of the head, beneath the chin and over the top, before the ears, was 725

FIG. 57. *Pongo pygmaeus*, the Orang-utan (young), from Smith College Museum.

mm., and the horizontal girth, across the eyebrows and the ears, was 750. [1 and 2].

[1]Recent literature gives much detailed measurement of the bones of the various hominids, especially the skull, in connection with the modern development of Osteometry, but measurements of the body, corresponding to the Anthropometry on the living, are almost completely wanting. Such measurements, in order to be of use in comparison with man, should be taken upon

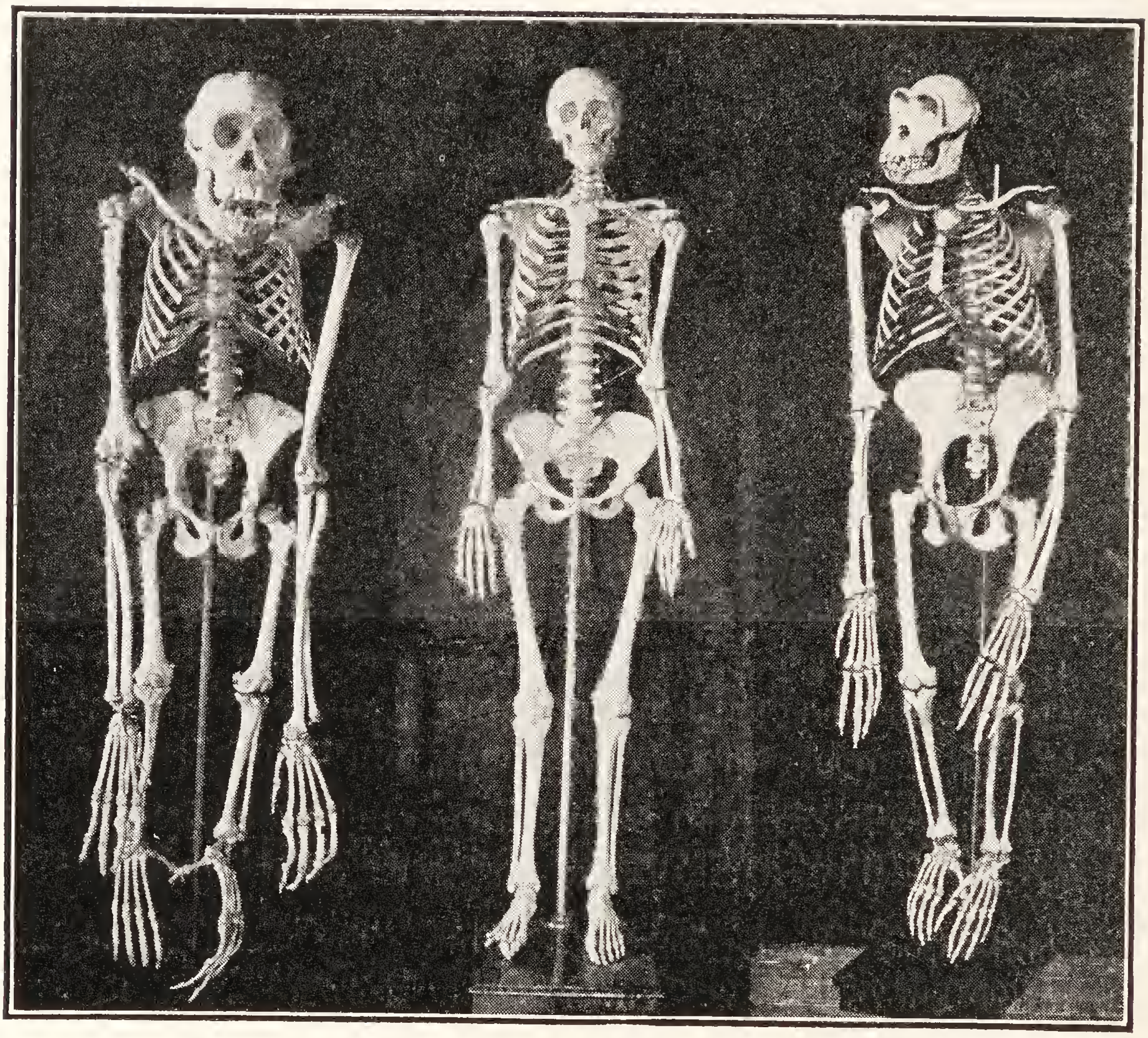

FIG. 58. *Pongo pygmaeus*, same skeleton as in Fig. 57; front view.
FIG. 59. *Homo sapiens* (female), from Smith College Museum.
FIG. 60. *Pan chimpanse*, from Amherst College Museum.

53. GENERAL CHARACTERISTICS OF THE HOMINID HEAD. The characteristic shape of the Primate head comes to its extreme development in the Hominidae. The face is large

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shaved specimens, to eliminate the error caused by the hair, but with the demand for stuffed museum specimens material of this kind is difficult to obtain. In this connection it may be said that probably no one has yet seen, much less studied, the naked face and head of a single simian ape, so that a careful comparison with Man has never yet been made. For careful skull measurements of the orang-utan, the gorilla, and the chimpanzee, cf. Selenka, Menschenaffen; Wiesbaden, 1899, Lieferungen 1 and 2. Jacoby, in Zeitschr. für Morphol. und Anthropol. Bd. VI, 1903, gives measurements of the teeth, and Adloff, Das Gebiss des Menschen und der Anthropomorphen, Berlin, 1908, treats of the jaws and teeth, also with measurements.

[2] DuChaillu gives (loc. cit. p. 301) some of the measurements of what he calls "the largest female gorilla I ever saw." These are unfortunately in feet

and broad, flatter than in other mammals, and the cranium, which is large and dome-like, often rises up in so unusual a manner as to add a broad superciliary surface, the forehead, to the already large facial surface.

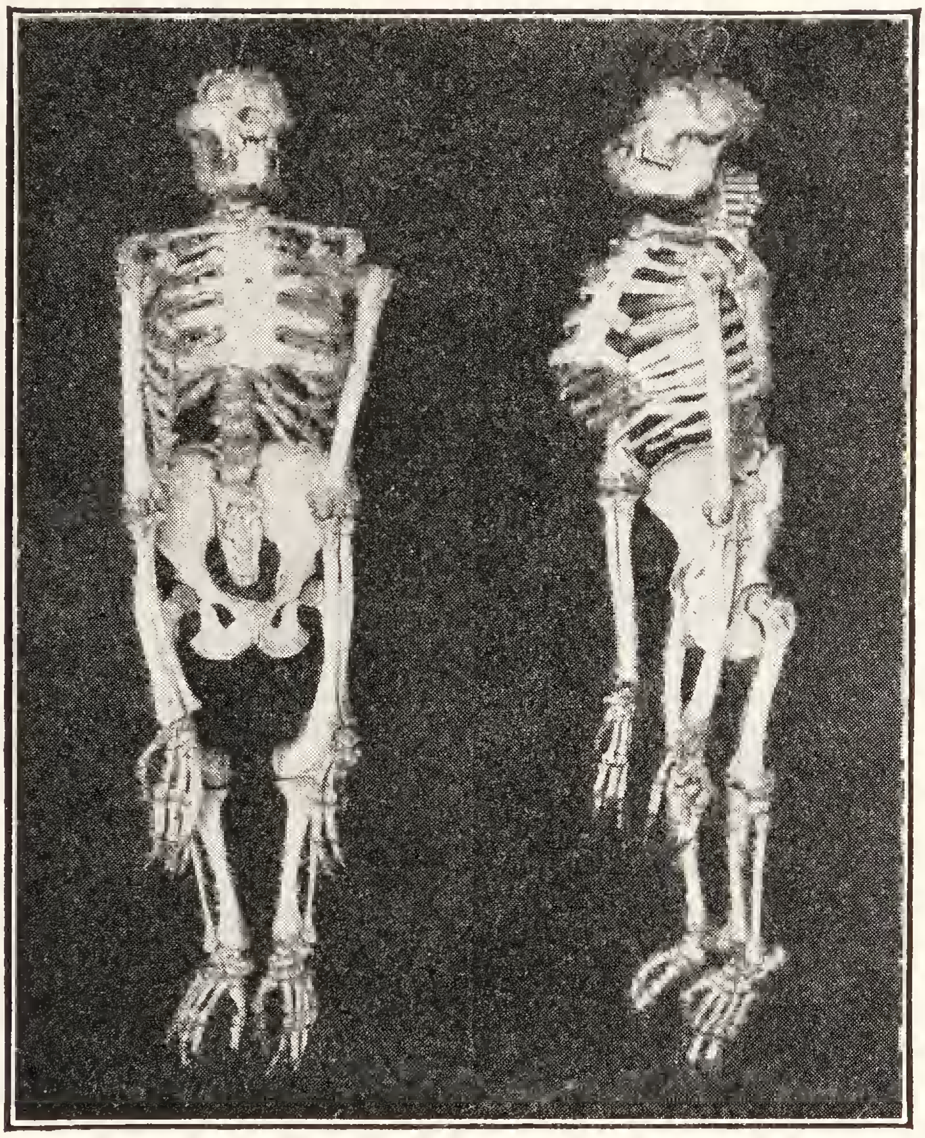


FIG. 61. *Gorilla gorilla*, front, from Amherst College Museum.
FIG. 62. *Gorilla gorilla*, side, from Amherst College Museum.

This flatness of the face is primarily due to several factors; to a reduction in the size of the jaws and teeth, and the

and inches, but are seen at once to be quite conservative. Total height, 4 ft. 7 in.; length of hand 7½ in.; length of foot 8½ in.; round of hand, above thumb, 9½ in. For adult males he gives the height of two as 5 ft. 2 in., and 5 ft. 8 in., but states that "adult male gorillas measure from five feet two inches to six feet two inches," adding that, as they do not stand erect, one of this latter stature would appear to be not more than five feet nine. Apparently authentic photographs of a gorilla of nearly six feet are shown in the *Wide World Magazine* for Dec. 1912.

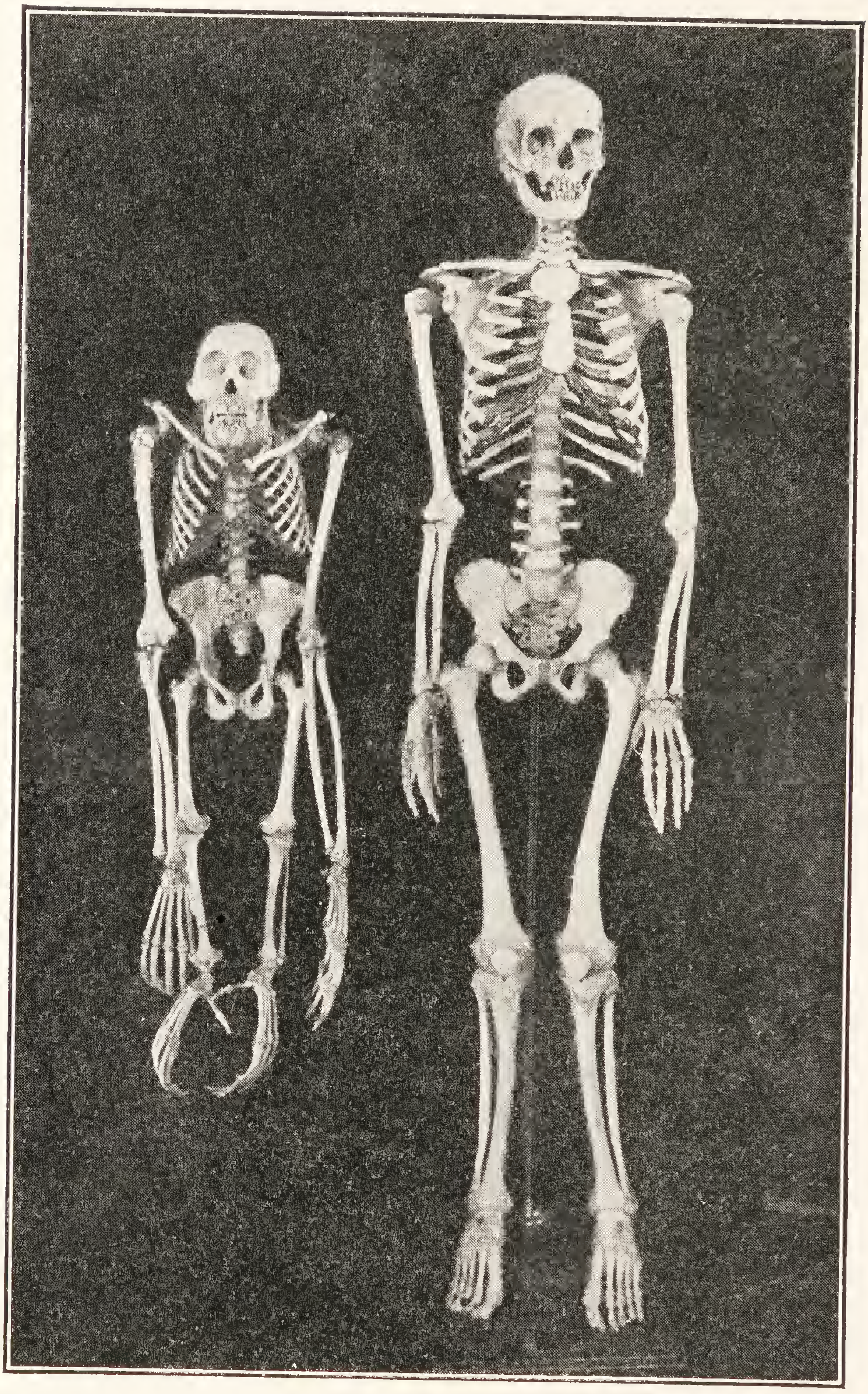


Fig. 63. Photographs of man and young Orang-utan, from the Smith College Museum.

consequent recession of these parts, to the large size of the orbits, their rotation forwards from the primitive lateral position, so that the optical axes of the two eyeballs are directed forward and are practically parallel, and to the development of the large dorso-lateral portion of the orbital wall, which flares laterally, and forms often a considerable addition along the sides at the level of the eyes. The first of these tendencies, the reduction of the jaws, is, in general, progressive within the limits of the Order of Primates; that is, it is not especially marked in the lowest members, but becomes more so in the higher ones, and reaches its limit in Man, where, indeed, an appreciable difference is seen between the lower and the higher races. This character is, however, a fluctuating one, and is so largely dependent upon the size of the teeth that if, for any cause, a species needs large teeth, its jaw becomes heavy and its snout prolonged, quite beyond that of its near allies.

Occasionally, even, as in the gorilla, the male only may develop heavy canines for defensive purposes, and will show the inevitable correlation of jaw and snout much in excess of those of the female of the same species. The orang-utan shows extreme prognathism in both sexes.

Excessive size of the orbit, on the other hand, is best seen in the lower forms, and reaches an exaggerated development in *Tarsius*, and its extinct allies (*Tetonius*, etc.); while they become less marked in the higher Primates and in Man, some of the special features of this development are all but lost. Naturally the primary cause of the huge bony orbits, with their reinforced margins, lies in the development of very large eyeballs, an adaptation to the necessities of a nocturnal habitat, especially that of seeing small objects, like nocturnal insects, at close range in a dim light, as is today the habit of *Tarsius*. This increase in the size of the eyeballs, and the accompanying rotation of the axes forward, has caused them to approach nearer together, and, as has also happened in the case of birds to an even

greater extent, the eyeballs have encroached upon the nasal cavities, and caused a considerable reduction in their size and efficiency, so that the sense of smell becomes almost rudimentary.

The increase in the cranial vault and the formation of a forehead are the direct results of the increase in the size of the

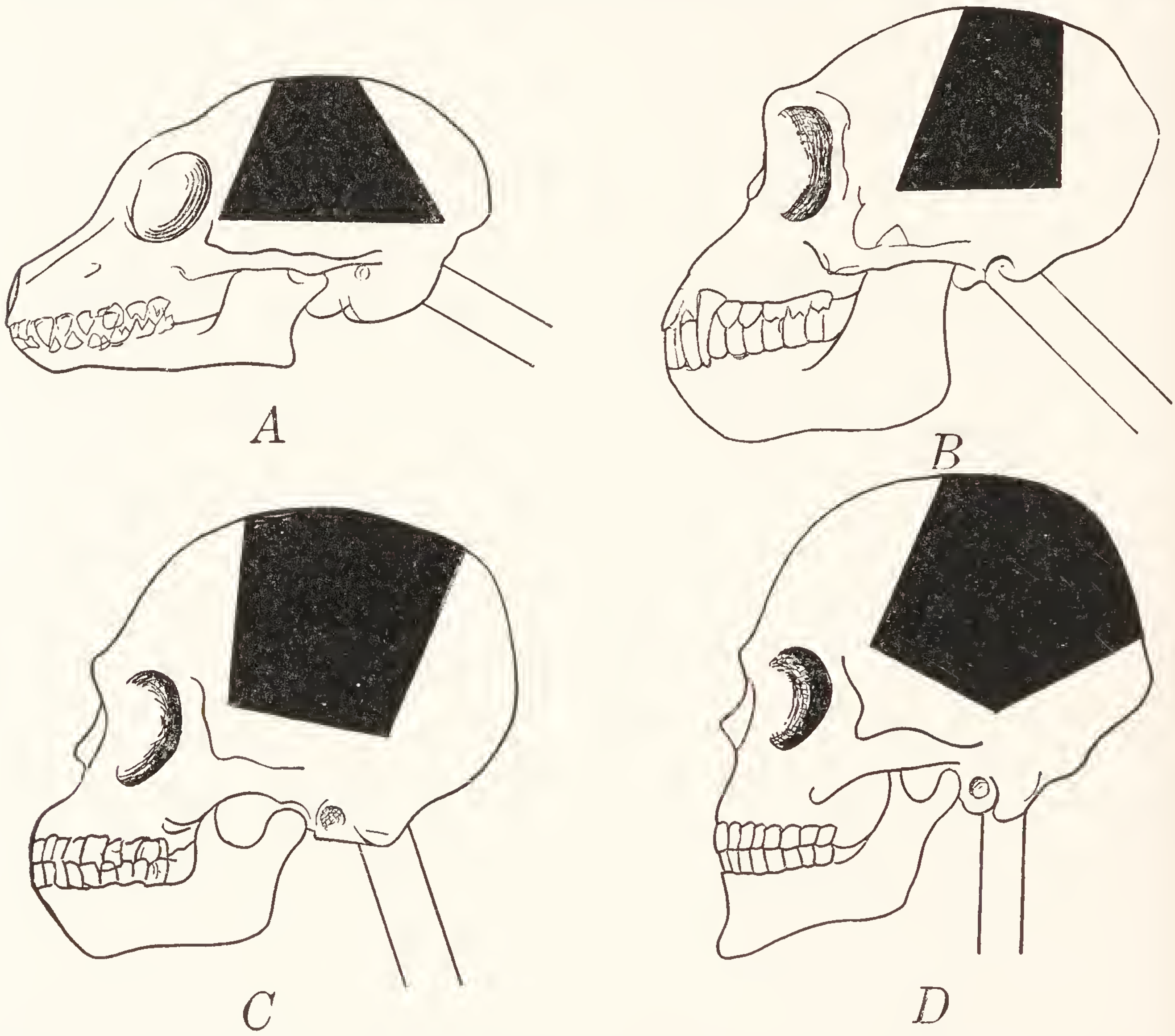


FIG. 64. Diagram of Primate skulls, showing the modifications occasioned by lifting the roof-dome or calvarium. The frontal and occipital bones, which begin nearly in contact, gradually spread apart, as the entire dome is lifted up, so that the parietal bone, in order to fill in the intervening space, changes its shape markedly. In the earliest stage, its upper border is much less than its lower one; eventually it is quite the other way.

brain, the most important of the numerous lines of specialization attempted by the Primates. This enlargement of the brain is reflected in the anthropoid skull in many ways, and furnishes the cause for some of its most characteristic features. The dorsal wings of the frontal and occipital

(supra-occipital) are lifted up and at the same time separated from each other; and the squamosals also become increased in a dorsal direction. Strength to support the increasing weight of the brain, although mainly effected by the fusion of certain elements of the basis cranii, is gained in part also by the fusion of the two frontals in the middle line, a change which takes place soon after birth. With the greater dis-

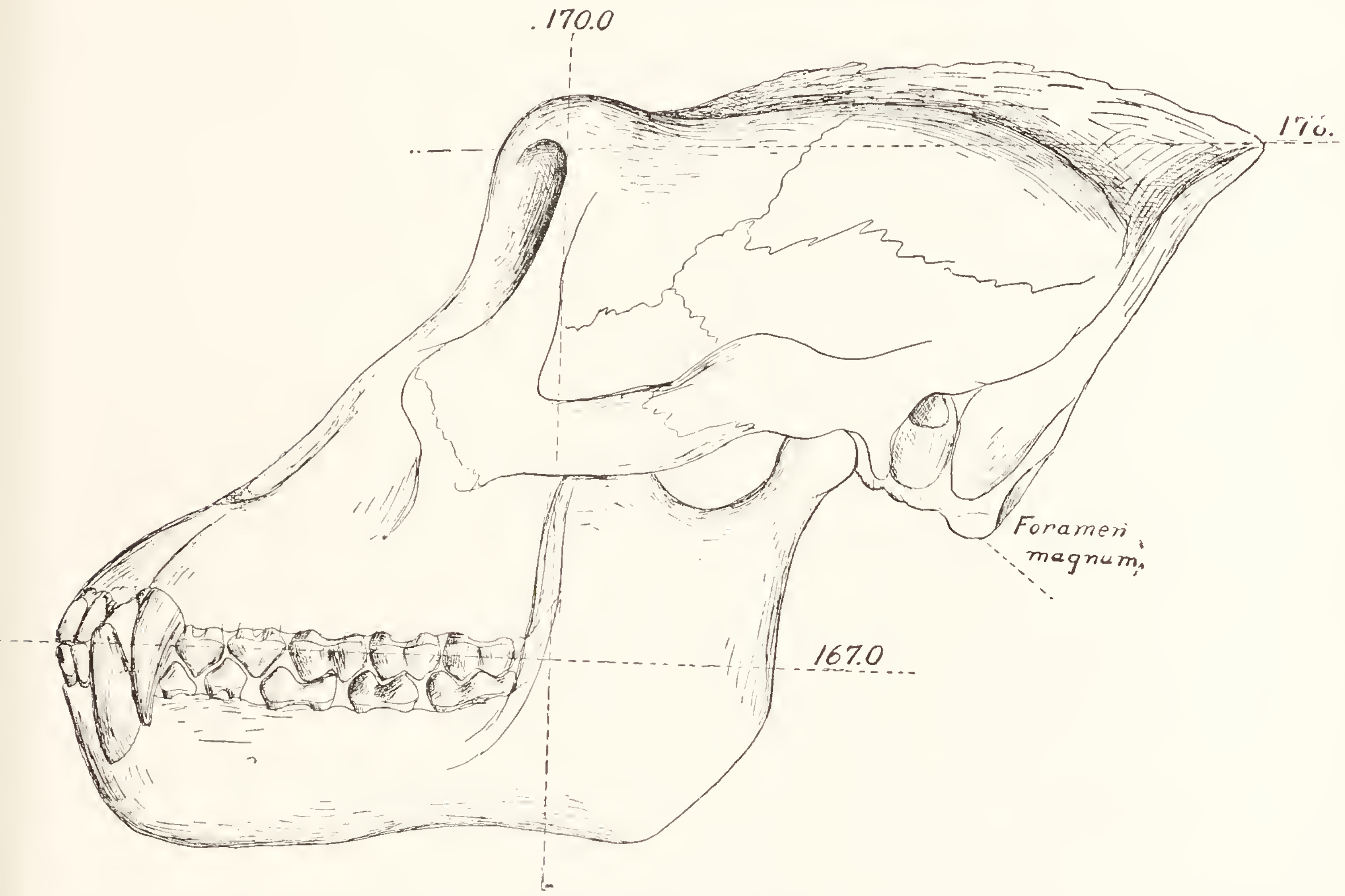


Fig. 65. Skull of *Gorilla gorilla* (male). Drawn from a specimen in Brown University.

tance between the dorsal edges of the frontal and supra-occipital the intervening parietals are also affected, and become elongated antero-posteriorly in order to fill the space that intervenes. This increase of the occipito-frontal interval, because of the retreating lateral margins of the frontal and supra-occipital bones, affects the dorsal margin more than the ventral one, and it thus happens that with the lifting of the cranial roof the parietal bone, which is at first a trapezium with the base, or longer parallel side below,

becomes in turn a parallelogram, with the two horizontal sides equal, and eventually an inverted trapezium, with the longer side at the interparietal suture. The first condition is

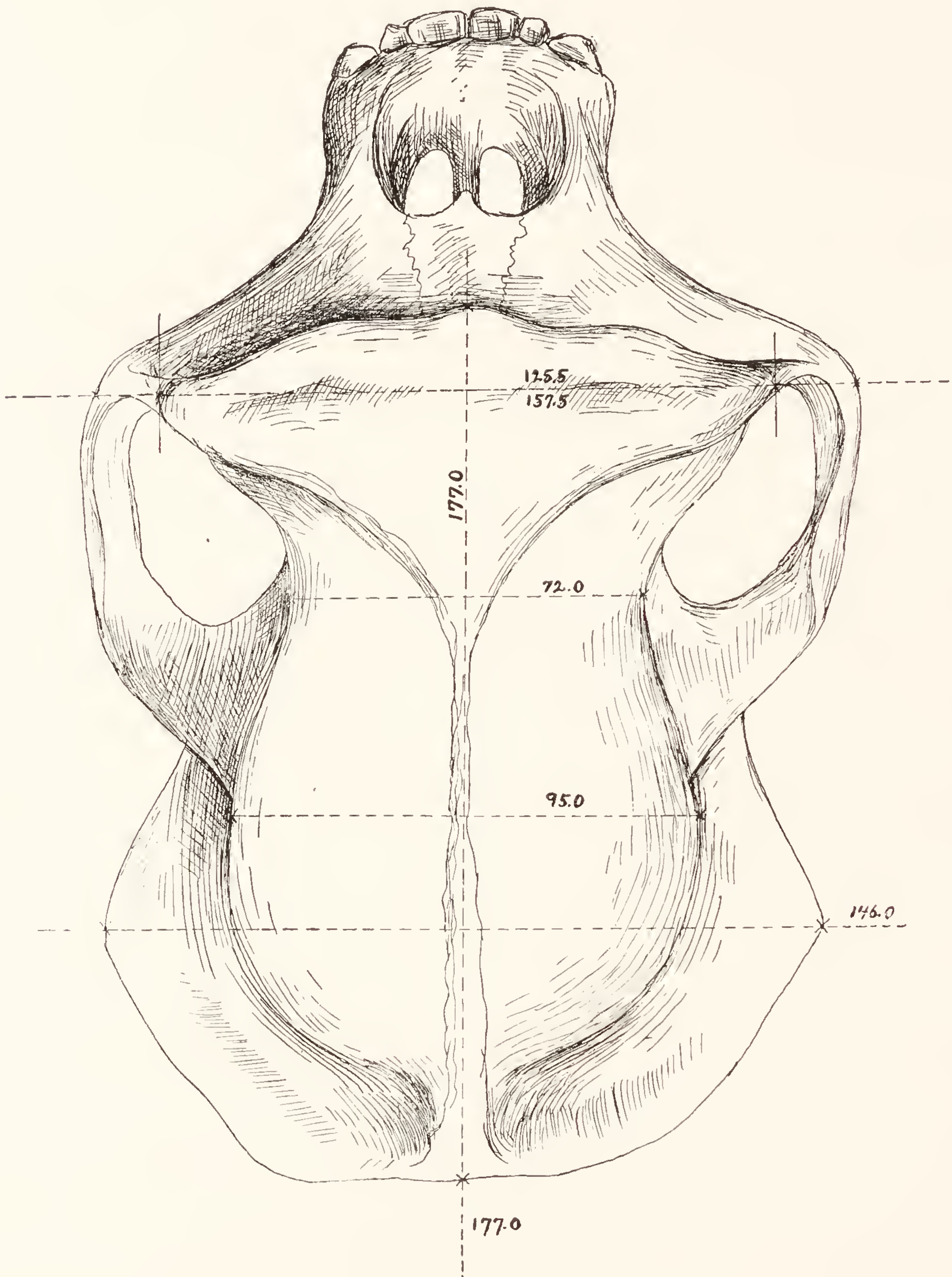


FIG. 66. Same skull as in the previous figure (65), but drawn from above (*norma verticalis*), showing the crests.

universally met with in monkeys and apes, while in recent Man the latter condition is the rule.

Externally the hominid cranium presents certain features

the variations of which produce marked superficial differences, without affecting the capacity or the internal shape. The chief of these is due to the temporal muscle of the jaw which lies in the temporal fossa. This muscle arises from a considerable area on the side of the skull, behind and above the zygomatic arch, and becomes inserted by a stout tendon

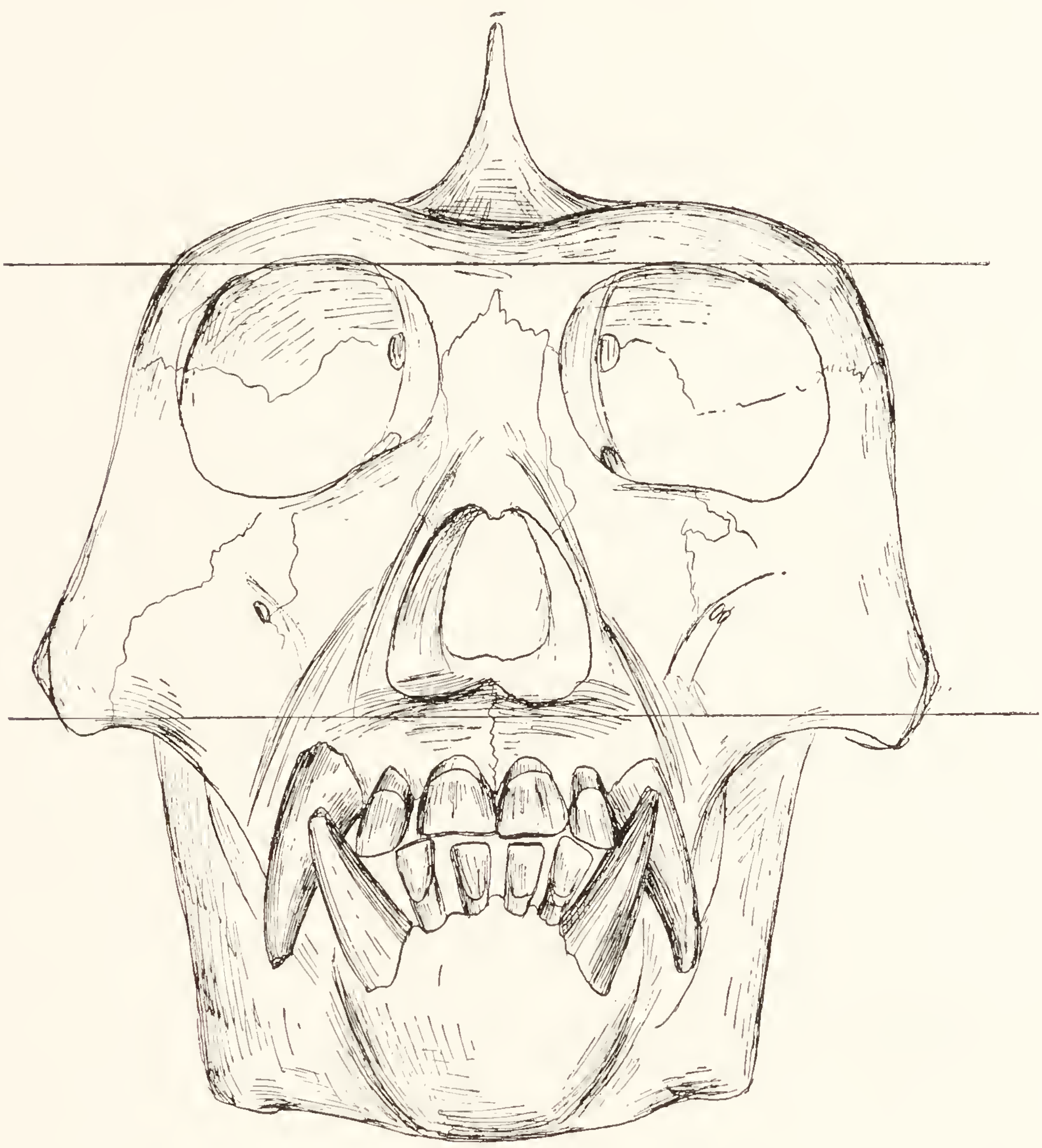


FIG. 67. Same skull as in the two previous figures (65, 66); front view (*norma frontalis*).

into the coronoid process of the mandible. Its upper limit is marked on the surface of the bone by a distinct line, the *temporal line*, the location of which differs in direct proportion to the proportionate size of the muscle, being placed low down on the side of the head when the muscle is small, and

higher up when the muscle is better developed. In cases where the jaw and teeth are especially heavy, and there is need of an exceptionally large temporal muscle, those of the two sides may come in contact along the mid-dorsal line of

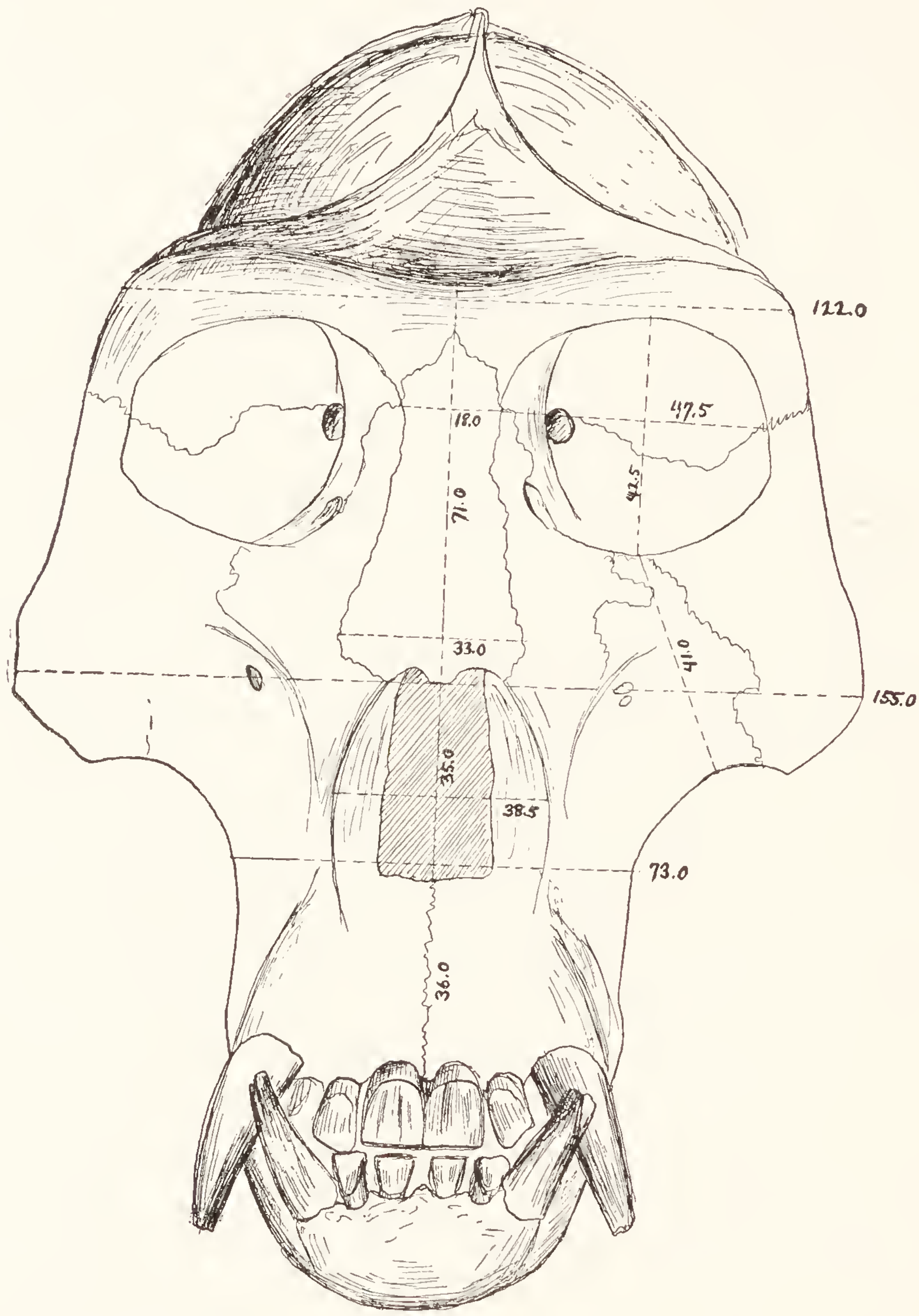


FIG. 68. Same skull as in the previous figures, drawn in the plane of the face.

the skull, and in extreme cases the conjoined temporal lines may develop into a conspicuous median ridge or crest. This is well seen in the male gorilla figured here. (Figs. 65-68).

A similar feature, often associated with the foregoing, is

the occipital line, which runs transversely across the occipital region and marks the upper limit of the insertion of the muscles of the back of the neck. This line advances dorsally in proportion to the development of these muscles, and in the case of an excessive development of both temporal and neck muscles the two crests, occipital and temporal, meet at a point upon the occipital bone from which they run,

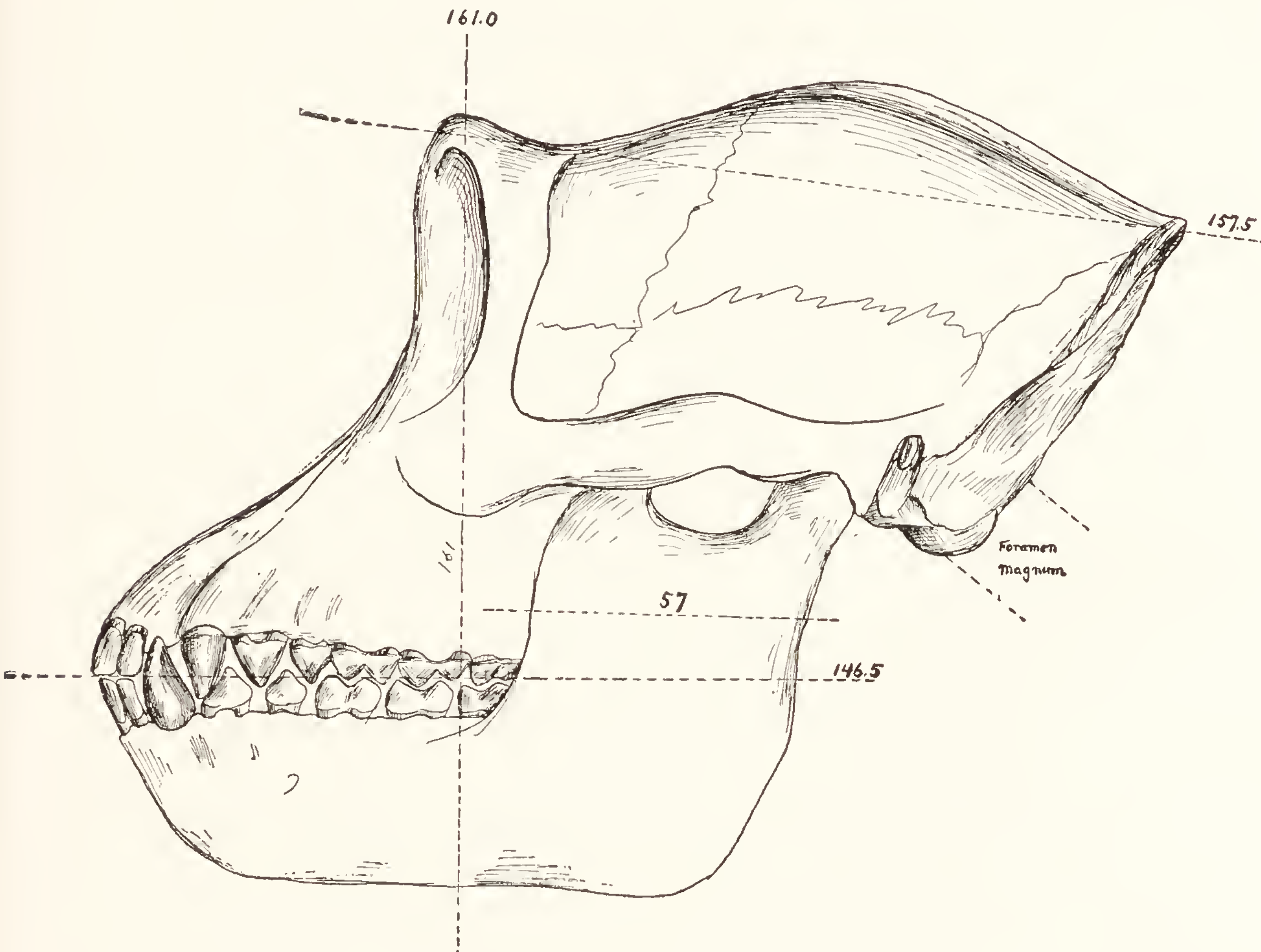


FIG. 69. *Gorilla gorilla* (female), drawn from a specimen in the Brown University Museum.

the occipital crest laterally, and the temporal sagittally like an inverted Y. Since the degree of development of these crests is in exact proportion to the size of the jaw and teeth, it is in part a character that varies with the age and sex of the individual, although the range of the development in each species is fairly characteristic. In the gibbon and chimpanzee, for example, the crests are only moderately developed, even in the adult males, and the skulls are more

like that of Man, exhibiting a smooth and rounded contour; but in the orang and gorilla they are larger, and in large males they become excessive, quite transforming the general aspect of the skull, and giving the whole a very brutish ap-

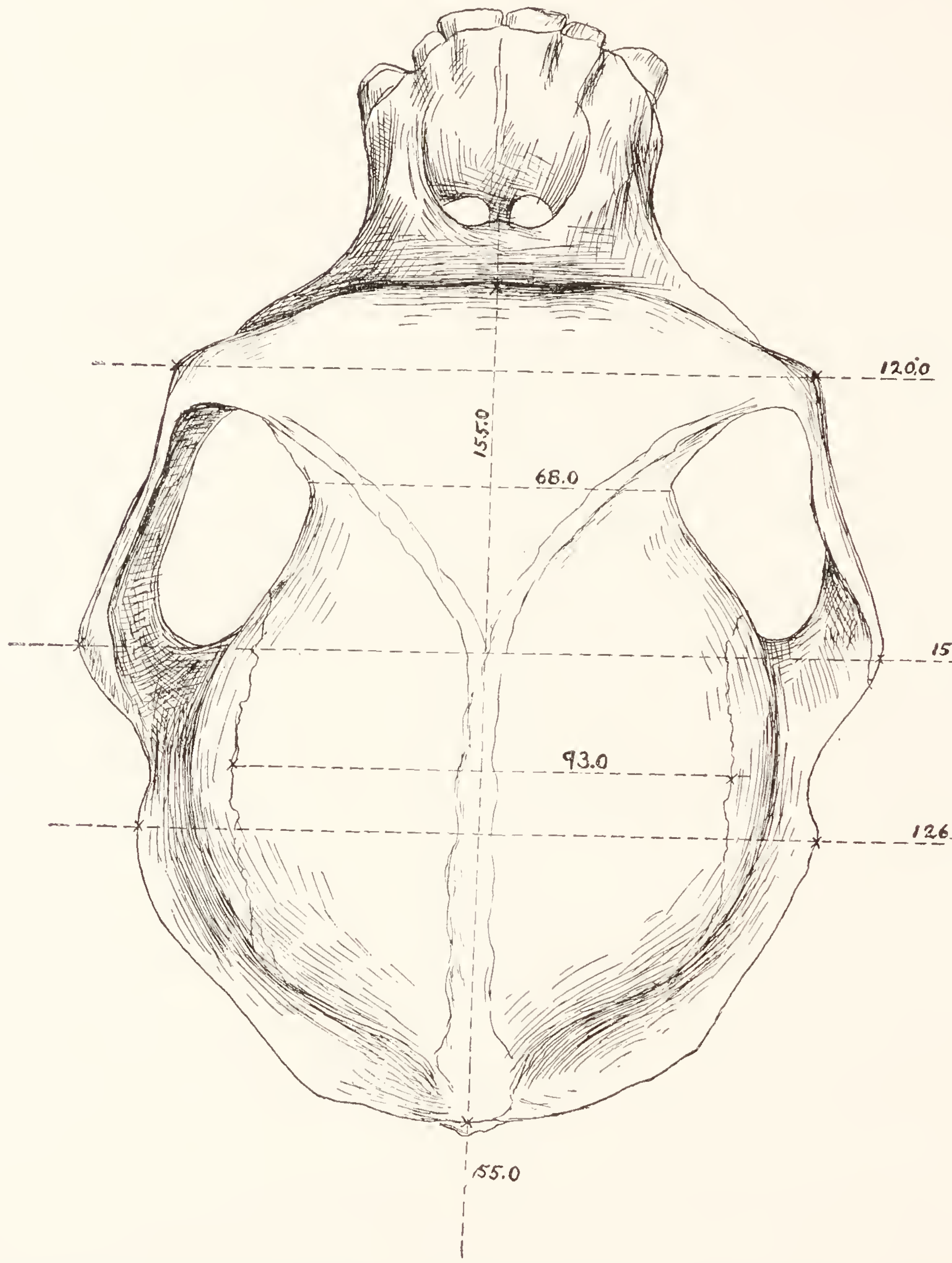


Fig. 70. *Gorilla gorilla* (female). Same skull as in the previous figure (69), drawn from above (*norma verticalis*).

pearance. In such species the superficial difference between the skulls of the two sexes, and between those of different ages, is very great, so that one would scarcely place them in the same Genus; and in making comparisons between the

different simians it is often best to employ those of females or of young animals, in order to eliminate these strongly marked superficial characters (Figs. 69 and 70). In *Homo* these lines, although well-marked, never appear as crests, and the temporal muscles never meet. Even here, however, there is some sexual difference in the size of the temporalis muscle, which advances the temporal line upwards in the

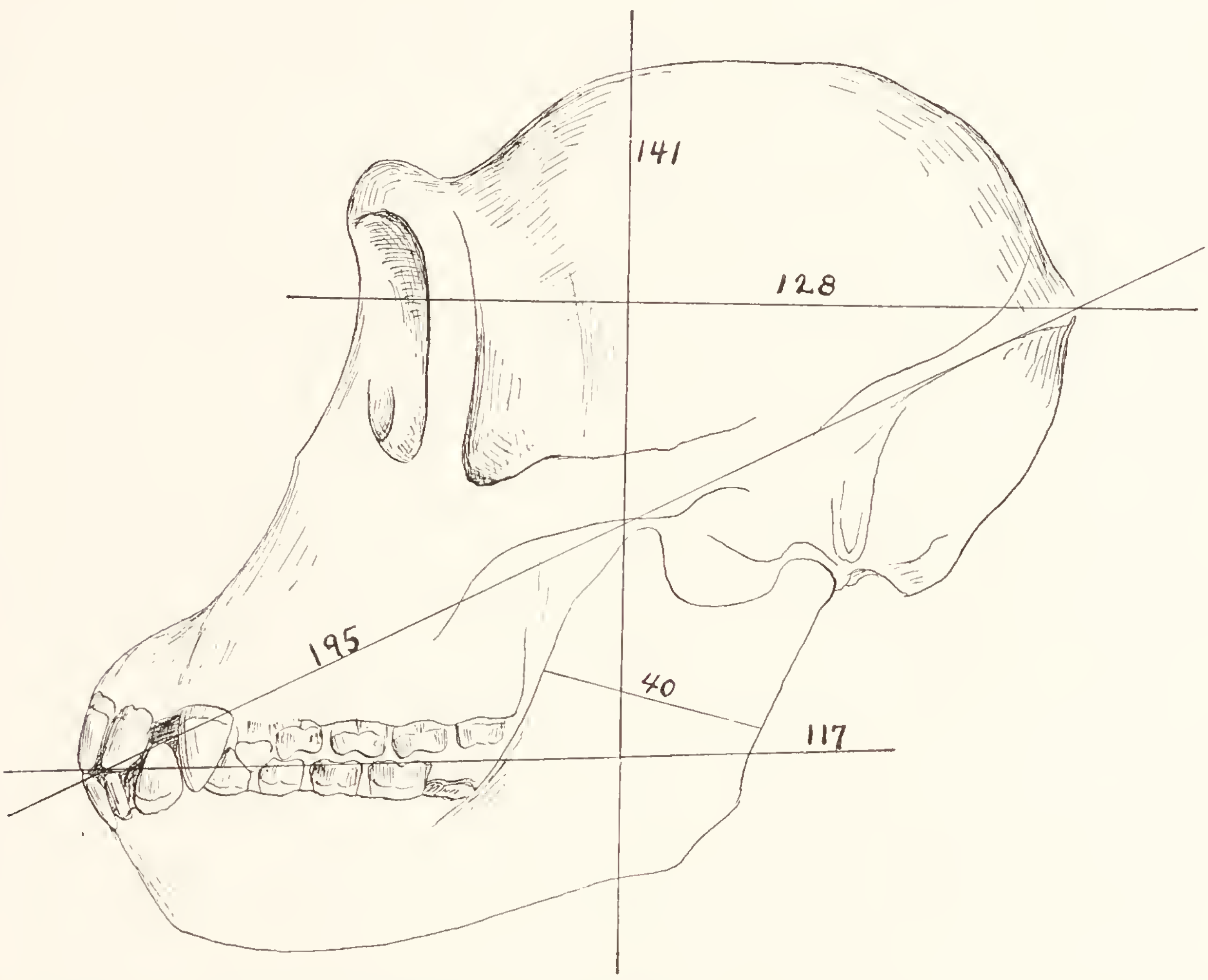


FIG. 71. Skull of *Pan chimpanse*, drawn from a skull in the Amherst College Museum; side view (*norma lateralis*).

male, so that in a given race the sex of a skull may be determined with some degree of accuracy by measuring the distance between these two lines, measured over the top of the head. When these features are present as definite ridges, with the corresponding differences in the size and thickness of the associated muscles, a distinct change is produced in the external appearance, and the contour of the head changes from a rounded one to one with three planes, like those of a trihedral angle.

That these ridges are wholly adult characteristics, correlated with the development of the large permanent teeth, is shown at once by the skulls of simian infants and children, where, even in the gorilla, which as an adult exhibits the most brutish development of external ridges, the childish contours are as smooth and round as in the human infant. For the same reason it follows that in childhood the head contours of all the members of the Family, including *Homo*, closely approach one another and with the later development

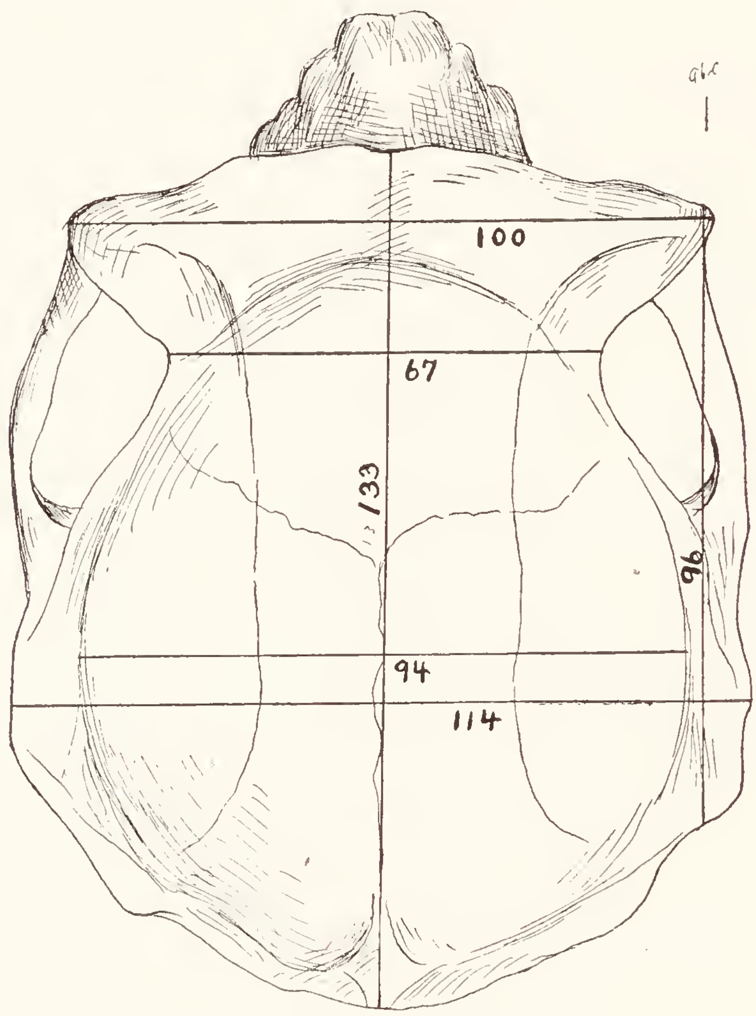


FIG. 72. Same skull as in the previous figure (71), from above (*norma verticalis*).

grow apart as they follow their subsequent differentiation. These characters, as both sexual and age differences, are well brought out in the painting of *Pithecanthropus alalus* by Gabriel Max, in which the rugged, triangular head of the male is seen in strong contrast to the rounded contours of the female and infant.

This correlation between the size of the teeth and jaws,

the extent of the temporal muscles, and the position and character of the temporal line, is of much importance to the student of human prehistory, since, from the inspection of a fragment showing any one of these points, the others may be deduced.

54. The Facial Angle. The first attempt to place the comparison of skulls upon a definite mathematical basis

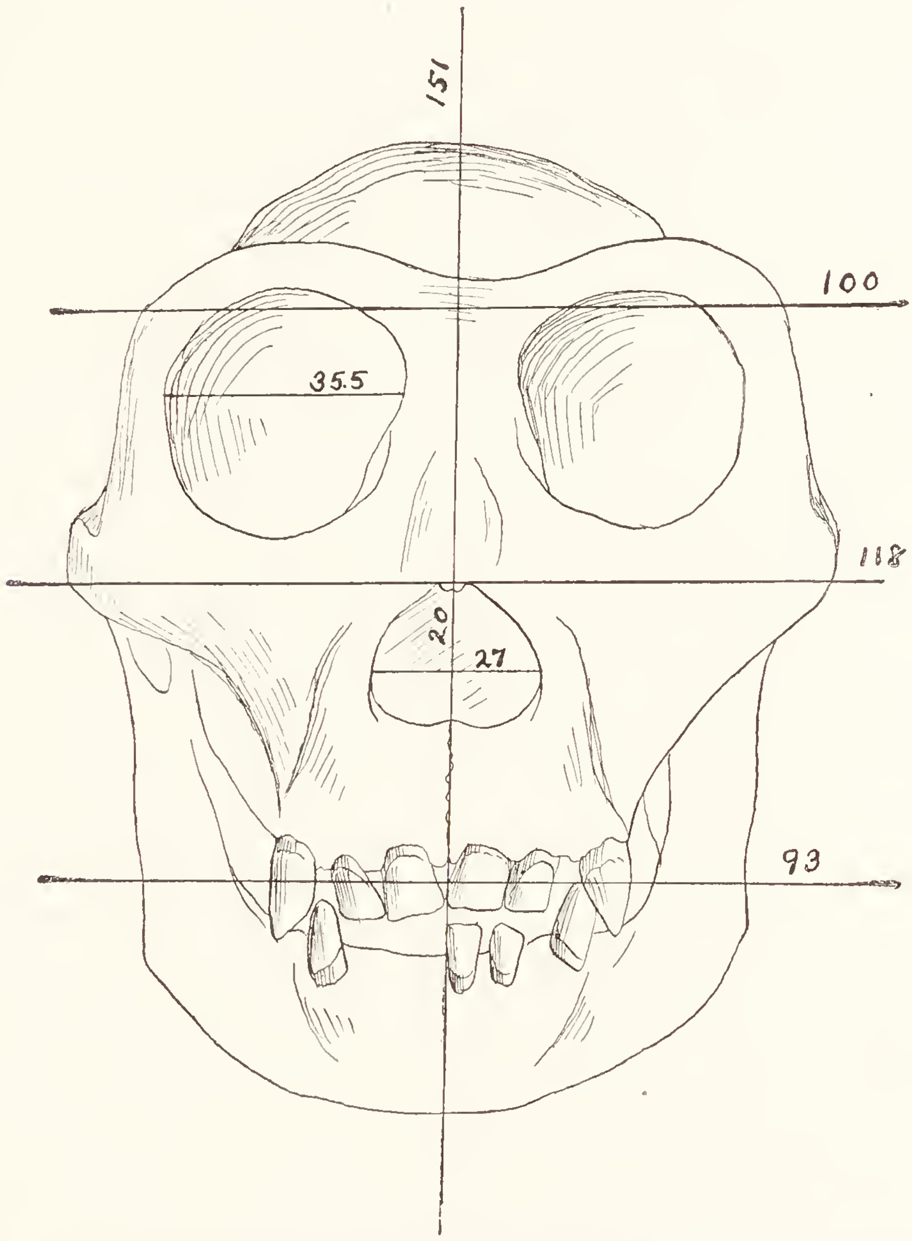


Fig. 73. Same skull as in the previous figures (71, 72), from the front (*norma frontalis*).

was that of Petrus Camper (1786), who drew projections of both skulls and living heads as seen from the side (*norma lateralis*), and compared the slant of their profiles by means of what he termed the "*facial angle.*" It is believed that Albrecht Dürer made use of a similar method, and Camper's

main idea was to give artists a definite working basis for the delineation of the human face. Camper drew first "a horizontal line along the lower part of the nose and along the ear-passage, preferably keeping in eye the direction of the cheek bone"[1]; crossing this he drew a line tangent to the profile of the face, resting on the protuberance of the forehead and the edge of the upper front teeth. The angle

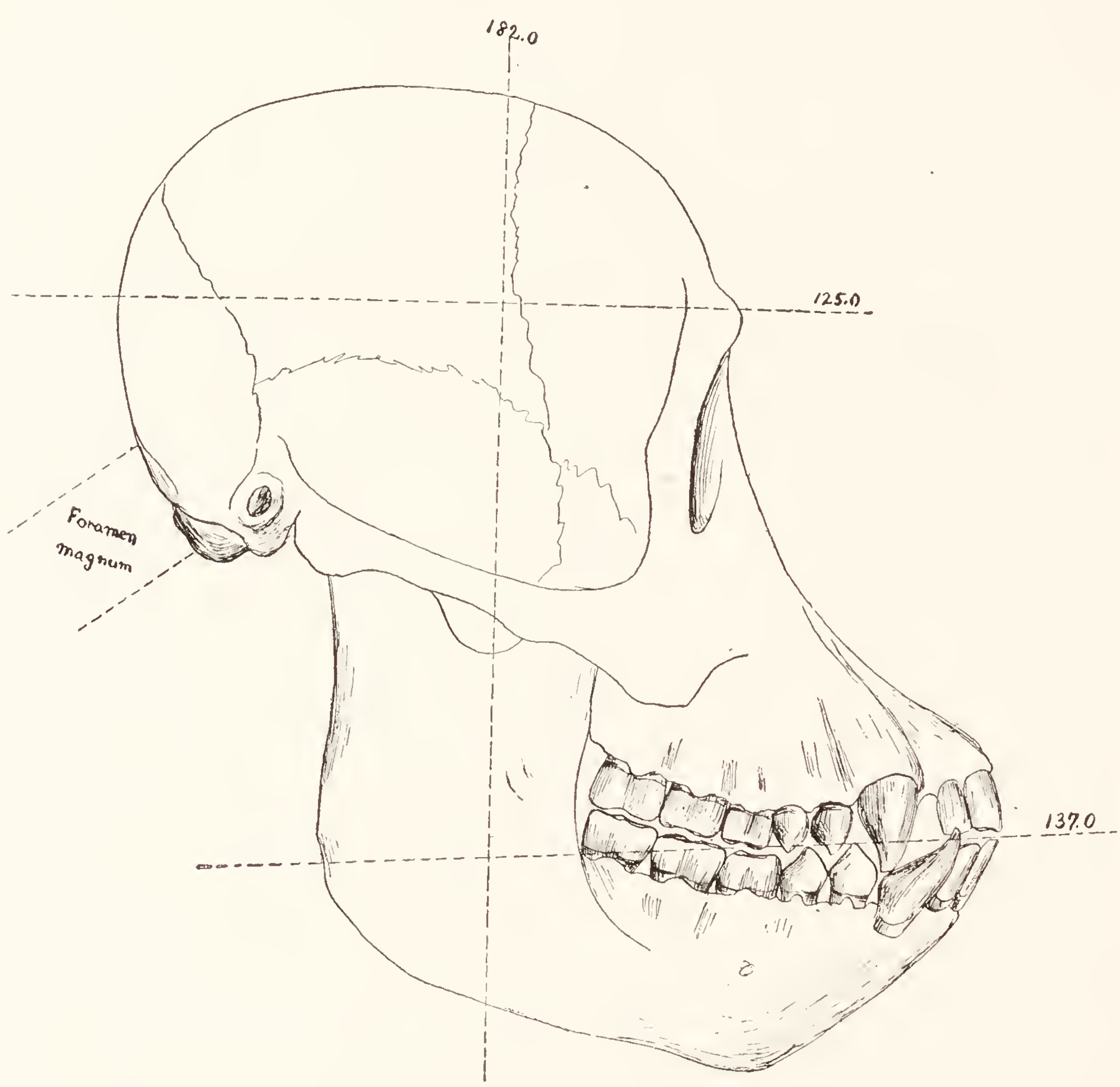


FIG. 74. Skull of *Pongo pygmaeus* (female), drawn from a specimen in the Brown University Museum.

formed by these two lines, is the *facial angle* (cf. Fig. 76).

For the average European Camper determined this angle to be 80°; for a negro, 70°. "If the facial line be inclined

[1] Petrus Camper. Dissertation sur les differences realles que presentent les traits du visage chez les hommes de differents pays et de differents ages. Paris, 1786. (Posthumous work, publ. by his son.)

beyond this, the profile is that of a monkey; below that, a dog. On the other hand the standards of Greek and Roman art are very high; the Romans employing an angle of 95°, and the Greeks one of 100°. Beyond the latter the head is hydrocephalic, and consequently pathological."

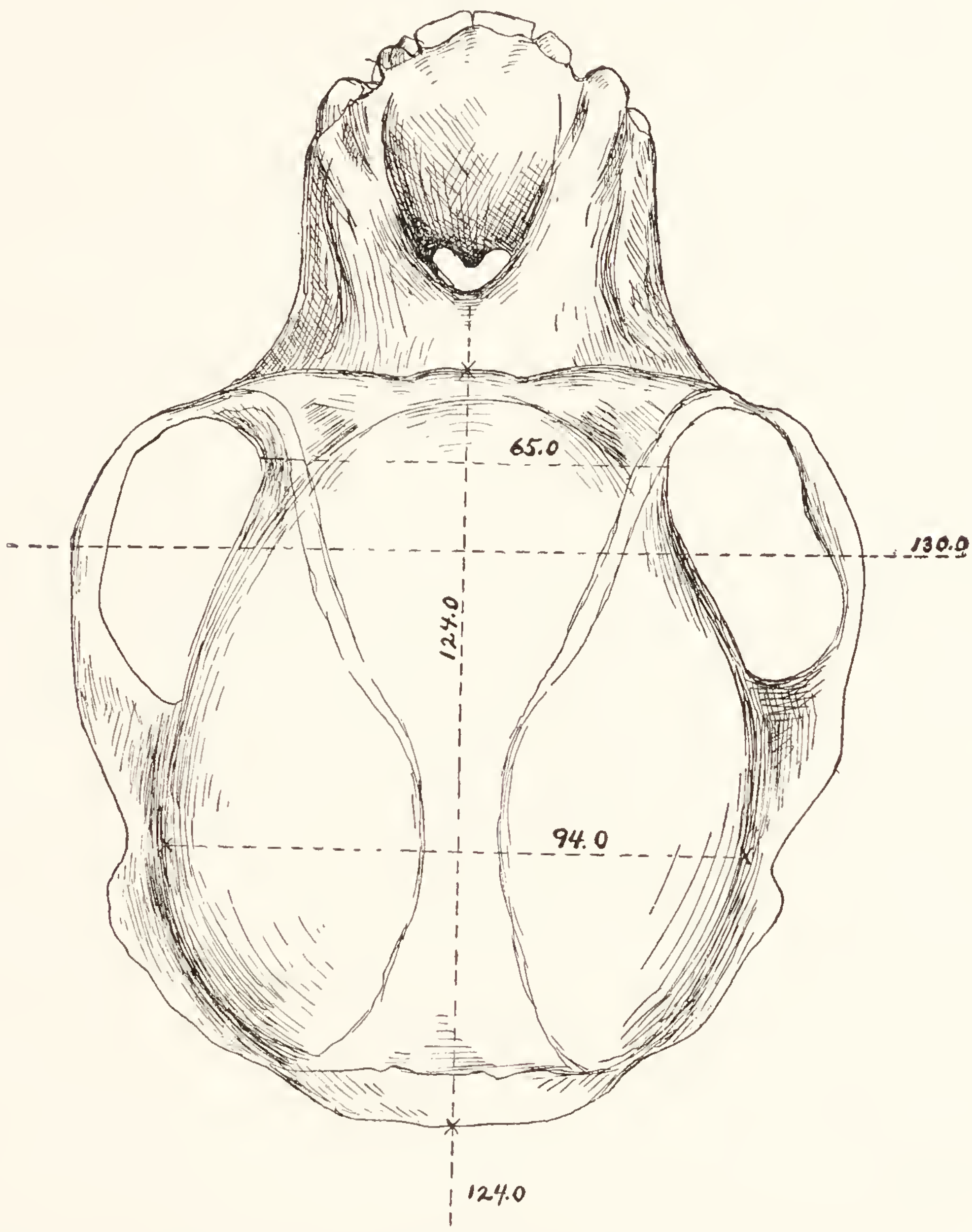


Fig. 75. Same skull as in the previous figure (74), from above (*norma verticalis*).

In this it will be noticed that a low angle signifies projecting jaws, the condition known technically as *prognathous;* while a profile with a high angle is *orthognathous*. In a way, also, the former signifies a more primitive condition, with a sloping forehead and small brain; the latter a more highly specialized one, with a high forehead and large brain; so that the Facial Angle becomes, to some extent, and with

many exceptions due to modifying conditions, an index of brain capacity.

As was to be expected from the pioneer character of the work, Camper's lines were not very definitely determined, nor were they in the best location for bringing out the true

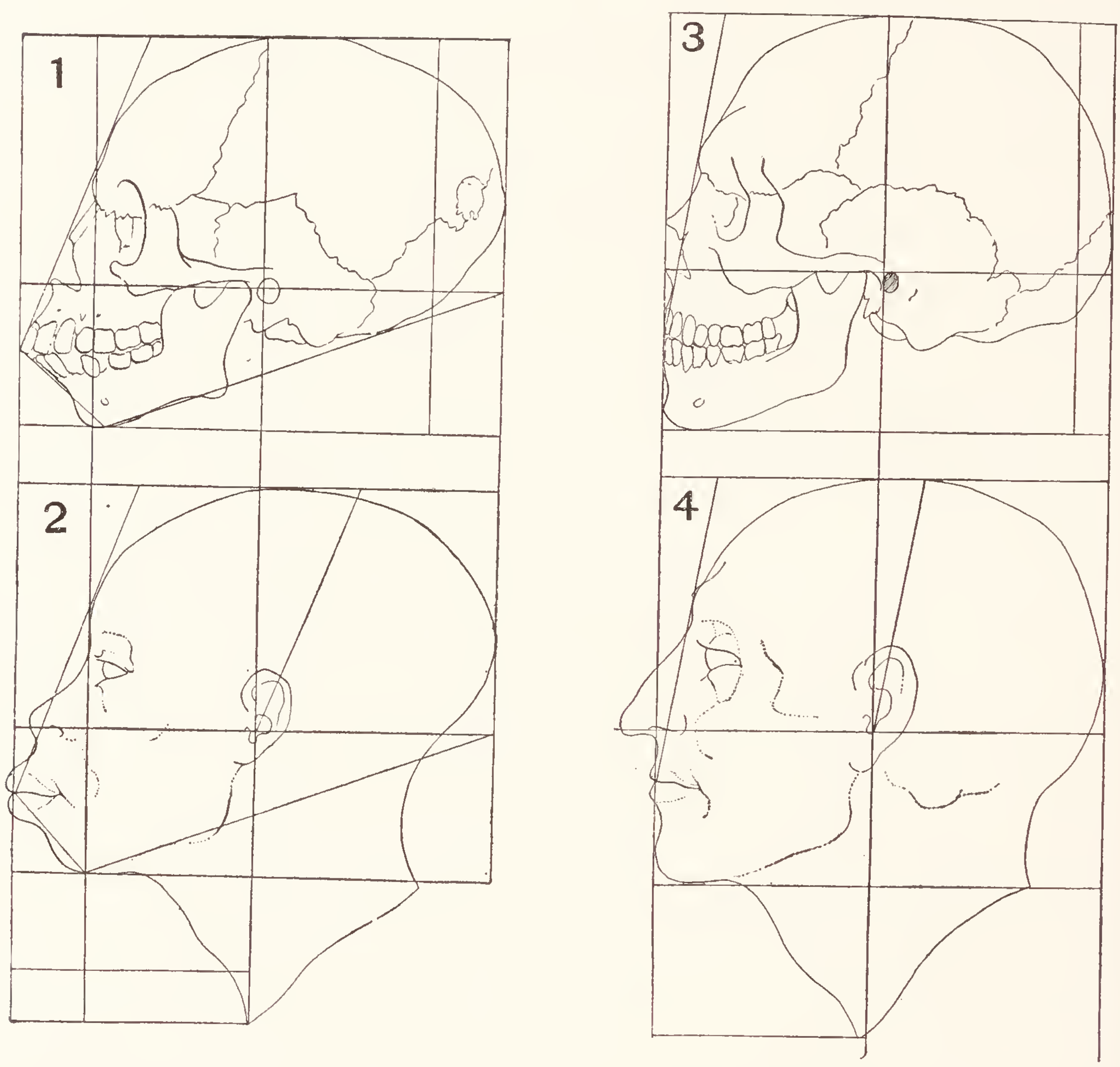


FIG. 76. Comparisons of the Facial Angle of the European and the Negro:—
1. Negro; skull. 3. European; skull.
2. Negro; life. 4. European; life.
After Petrus Camper.

differences. The angle is also of such a nature that its value for comparison between such widely different forms as are included within the limits of the Primates is not very great, and it is most useful in detecting the rather minute differences between the various human races, that is, as an

anthropological measure in the strict sense. Since the time of Camper various other Facial Angles have been proposed and more or less extensively used, the lines of which they are composed being much more definite.

The following Table of facial angles, taken approximately in accordance with the rules of Camper, indicates in a general way the value of this mode of comparison, and shows roughly the degree of prognathism of the various simians. The data furnished by DuChaillu were taken in the field without special instruments, and must be considered only approximate; on the other hand in those of Topinard the glabella, or point in the middle between the superciliary ridges, is invariably used for the establishment of the facial line, and is thus more exact than the ordinary "tangent line" used by Camper.

TABLE III.

Facial Angle of Camper.

Newfoundland dog (Topinard)	25.0°
Gorilla, adult male (Topinard)	31.0°
Small Cercopithecid (Lasiopygid) (Camper)	42.0°
Orang (adult), average (Waruschkin)	46.6°
Orang (adult) (Camper)	47.0°
Gorilla (adult) (DuChaillu)	49.0° to 52.0°
Chimpanzee; *P. chimpanse* (DuChaillu)	54.0°
Chimpanzee; *P. calvus* (DuChaillu)	55.0°
"Kooloo-kamba" (*P. kooloo-kamba*) (DuChaillu)	57.0°
Orang, very young (Camper)	58.0°
Negro; Namaqua (Topinard)	59.0°
Gorilla, young (DuChaillu)	62.0°
Chimpanzee, *P. calvus*, young (DuChaillu)	65.0°
Negro (Camper)	70.0°
Kalmuck (Camper)	70.0°
European (Camper)	80.0°
European, Bas-Breton (Topinard)	81.0°
Antique Roman Art (Camper)	95.0°
Antique Greek Art (Camper)	100.0°

It will be noticed in this that the young of the lower simians show a much higher angle than do the adults of the same species; and, if the figures were accessible, the same result would attend the comparison of adult females with adult males. The cause is the same in both cases, namely, an excessive development of the teeth, especially the front ones, and a corresponding increase in the projection of the surrounding alveolar processes of the jaws, an effect not especially marked in the young, especially the infants without teeth, but well shown in all adults, and excessive in the males. It follows from this that in all Hominidae males are more prognathous than females, and the adults far more than the young. The sexual difference in this regard is, however, but little marked in *Homo*, as the dentition is almost equally reduced in both sexes; it follows also that the skulls of the young in the higher apes are more like Man than are the adults. Both of these points, the heavy, protruding jaws of the male and the oval skull of the infant, are well shown in the painting of the hypothetical *Pithecanthropus*, above referred to, which is valuable as a pictorial record of the essential simian characters becoming humanized.

55. Cranial Capacity and Brain Weight. A more direct method for obtaining the relative degree of mental development in the higher Primates than by the comparison of facial angles, is that furnished by an investigation, either of the brain itself or of the cranial cavity which contains it; that is, a direct comparison by means of weight or volume. In applying such a test it is, however, necessary that the animals compared be approximately of the same size and with a similar organization, since the increase in the mere bulk of an animal necessitates an addition to the substance of the brain in order to control the added mass of muscles, and to equip the added surface with proper sensation. If, for example, in two animals of about the same bulk in respect to their muscles, such as a monkey and a cat, the brain of the

former be found considerably larger than that of the latter, it may be taken as a direct proof of the greater psychic development of the monkey; or if in the comparison a smaller animal has a larger brain, as in a comparison between Man and the horse, so much the more is the greater psychic development on the side of the larger brain; but if, on the other hand, an animal of huge bulk, like the elephant or the whale, be found to have a brain actually larger and heavier than that of Man, the mass of brain necessary to control such a vast mass of muscles must be first taken into consideration, and subtracted from the rest, before a comparison of the relative psychic power of the two can be made.

While, then, allowance must be made for a difference in bulk, yet in animals of so nearly the same size and anatomical structure as the simians, taken among themselves, the difference in the size and weight of the brain may be directly compared, and, with some concession to the small size of the gibbons, may be used absolutely as a criterion of the degree of mental development, and the relative position of each in a series based upon this. It is also to be remembered that the small monkeys have far less actual bulk in their muscular system, and that their brains, although considerably smaller than in the Hominidae, still show up very well in a direct comparison with the usual household pets of about the same size, like dogs and cats. Thus any exercise of proper sentiment against cruelty to animals should be directed with double force in behalf of our poor little relatives, whose capacity, both for suffering and for appreciation of their benefactors, is so great, and who possess a psychic response to environment that causes them to suffer keenly under circumstances to which a cat, or even a dog, would be totally indifferent.

There are two methods of ascertaining the size of the brain, the one by measuring the capacity of the cranium, the other, the more exact one, by removing the brain when fresh, and weighing and measuring it directly. The first method, that

of measuring the cranial capacity, is easily performed at any time upon a prepared skull, and is hence much more available than the other method, which demands fresh material and a complete uniformity in the treatment. In calculating the weight and bulk of the brain from the measure of cranial capacity, however, two things must be kept in mind; the relation of the brain to the cavity and the specific gravity of the brain substance. In the living head the brain does not entirely fill the cranial cavity of the skull, but is surrounded by a double membrane, the dura and pia mater, and between these there is a narrow space filled with the cerebro-spinal fluid, to serve as a cushion and lessen the jarring to which the body is constantly subjected. The blood vessels and blood sinuses also occupy an appreciable space. As a result of this the actual bulk of the brain is a little less than the capacity of the cranium; but, on the other hand, as the specific gravity of the brain is a little more than that of water (its sp. gr. = 1030-1045), its greater weight is a partial compensation for its lesser bulk.

The brain is thus not far from 10-12% less, counted in grams, than the cranial capacity counted in cubic centimeters, and various authorities have endeavored to obtain the precise relation of the two. Manouvrier, for example, recommends multiplying the cranial capacity by 0.87 to obtain the brain weight; others vary in the figure between 85.58 and 95.90. The following list of various estimates has been collected by von Török:—

TABLE IV. Relation of Cranial Capacity to Brain Weight.

Weisbach	cran. cap.	:	brain weight	:	:	100	: 85.58
Hudler	"	:	" "	:	:	100	: 85.90
J. B. Davis	"	:	" "	:	:	100	: 86.32
von Török	"	:	" "	:	:	100	: 86.68
von Bischoff	"	:	" "	:	:	100	: 88.90
Welcker	"	:	" "	:	:	100	: 95.90

The average of all these, a number that might well be recommended for use in this connection, is 88.28.

J. Barnard Davis, an early investigator, employed the

following method of converting cranial capacity into brain weight. He first obtained the exact weight of his medium, sand, and subtracted 15 grams from each 100 to allow for the meninges, blood vessels, etc. Thus by using the two specific gravity values for sand and brain substance, respectively 1.425 and 1.040, he obtained his results.

The methods of ascertaining the cranial capacity of a skull are extremely numerous, and, as this measurement is an important one in the study of human craniology, much care has been taken to render the results as accurate as possible. The older investigators contented themselves with filling a skull with dried peas, first plugging with cotton the larger foramina, except the foramen occipitale, through which the peas are poured. After thus completely filling the skull, the latter are then poured out into a graduated glass and measured, a method which gives an approximate result. A finer material, like mustard or millet seed, small shot, or sand, gives naturally a more accurate result, but the finer the medium so much the more carefully must the holes be plugged, and in this process a constant source of error lies in the liability of the cotton to project into the cranial cavity beyond the limits of the foramen which it guards. Of late years water has been used with much success, introducing first a collapsible bag of very thin rubber of approximately the right size and shape. This is introduced into the foramen occipitale and the water is then poured into the bag, causing it to fill the entire cranial cavity. As by this process the thin rubber becomes stretched across the foramina, while it reaches every proper recess of the cranial cavity, the method is a very accurate one.

The following Table of cranial capacities is here presented, compiled from various sources, and obtained by the use of various media. The disparity in the results obtained by different authorities is largely due to the employment of different materials to measure with.[1]

[1] Broca used fine shot; Davis used sand.

TABLE V. Cranial Capacities of Various Mammals, especially Hominids.

Newfoundland dog	105 c.c.			
Ram	150			
Wild boar	207			
Bear	265			
Lion	321			
Chimpanzee (female)	320–450.	Average	390	(Selenka)
Chimpanzee (male)	350–480.	"	420	"
Orang-utan (female)	300–490.	"	390	"
Orang-utan (male)	360–530.	"	455	"
Gorilla (female)	380–530.	"	450	"
Gorilla (male)	420–590.	"	510	"
Pithecanthropus (estimated)	850 (Dubois)			
Homo neandertalensis (estimated)	Neanderthal 1230 La Chapelle 1616 (Boule)			
Homo sapiens				
Australians	1181–1347	(Broca);	1295	(Davis)
Negroes; W. Africa	1251–1430	"	1340	"
Chinese	1383–1518	"	1452	"
Eskimos	1428–1539	"	..	
French	1337–1555	"	..	
Swedes	..	..	1500	"

The rate of increase in the human cranial capacity during the growth period is expressed in the following Table:—

TABLE VI. Cranial Capacity in Human Development. (Europeans) (after Welcker, from Topinard)

Age	Males	Females
New-born infant	400 c.c.	360 c.c.
Two months	540	510
One year	900	850
Three years	1080	1010
Ten years	1360	1250
20–60 years	1450	1300

The direct weight of the brain is extremely difficult to obtain, especially in the case of the larger apes, since the organ must be in a perfectly fresh condition, and in the wild countries which form the habitat of these creatures the

means of measurement are seldom at hand. After preservation the weight is no longer to be trusted, since the brain may either lose weight through the absorption of its fluids by the action of the preservative, or may gain weight through the addition of chemicals which it may have itself absorbed. Thus a brain long preserved in alcohol, through the substitution of a lighter for a heavier fluid, and through the reduction in the quantity of fluid held because of the shrinkage in total bulk, is lighter by a fourth to a third than is the same brain when perfectly fresh.

The following Table gives the weight of the brain in various Primates, including the brain weights of numerous human races. The brains were all weighed in the fresh condition, unless otherwise specified.

TABLE VII. Brain Weight of Primates (in grams).

Lemurs	
Nycticebus (*Loris*) *tardigradus*	8.18
Peridicticus potto	9.5–13.0
Lemur mongoz	21.1–28.0
American Monkeys (Platyrrhini)	
Hapale (*Callithrix*) *pennicillata* (long in alcohol)	2.6
Midas (*Leontocebus*) *rosalia*	11.8–12.8
Mycetes (*Alouatta*) *seniculus*	47.6
Cebus capuchinus	69.5
Ateles (*Ateleus*) *ater*	126.0
Cercopithecidae (*Lasiopygidae*)	
Papio sphinx	160.0–179.0
Macacus (*Pithecus*) *nemestrinus*	76.0–114.0
Cercopithecus (*Lasiopyga*) *cynosurus*	70.5
Semnopithecus (*Pygathrix*) *obscurus*	64.3
Simiidae (*Hominidae*)	
Hylobates leucisus	94.5
Hylobates lar	89.0– 96.0
Hylobates (*Syndactylus*) *syndactylus*	100.0–130.0
Simia satyrus (*Pongo pygmaeus*)	
Young male (Manouvrier, 1888)	365.0
Male, adult (Deniker and Boulart, 1895)	400.0

Simia satyrus (*Pongo pygmaeus*)	
Young specimens (Weber, 1896)	306.0 334.5 339.0
Male, adult (Milne-Edwards, 1894)	400.0
Pan niger (*chimpanse*)	
Female, two years old (Giagomini, 1888)	310.0
Male, four years old (Bischoff, 1871)	277.0
♀ 5 yrs. (Chapman, 1879)	285.4
♂ Not quite grown (Tyson, 1699)	324
Almost grown (Spitzka, 1879)	390
Gorilla gorilla	
2-3 yrs. (Manouvrier, 1888)	416
Adult (Owen, 1865)	425
Homo sapiens	
Australians ♀ (Owen)	907
Australians ♀ (Davis)	1169
Australians ♂ (Davis)	1197
Bushmen (Marshall, Flower)	974
African negroes ♀ (Broca)	1067
African negroes ♀ (Peacock)	1232
African negroes ♂ (Broca)	1316
African negroes ♂ (various sources)	1238
Germans ♀ (Wagner)	1209
Germans ♀ (Huschke)	1244
Chinese (Schuster)	1361
Germans ♂ (Wagner)	1392
Germans ♂ (Huschke)	1382
Magyars (Hungary) (Weissbach)	1323
English and Scotch ♀ (Peacock)	1260
English and Scotch ♂ (Peacock)	1427

From these and many other figures Bardeleben, 1899, has calculated as the average brain weight for Europeans: males 1353 g., females 1226 g.[1]

[1] Poynter (in Univ. Stud., Lincoln, Neb., 1912) gives the following table of brain weights of eminent scholars:—

Race	No. Examined	Weight
American	27	1519
British	14	1481
French	20	1456
German	38	1439
Italian	1	1495

Total No. 100. Average, 1478 grams.

Aside from the absolute brain weights, given in grams, the total weight of the various animals and the proportion between brain weight and body weight should be taken into consideration. By this it will be seen that the Primates exceed all other animals in the proportionate weight of brain. Thus, for example, while the brain weight of the black bear (407 g.) nearly equals that of the gorilla (425g.), the brain weight in the latter case is $\frac{1}{213}$, of the whole, while in the former it is but $\frac{1}{484}$, that is, proportionately, the brain of the gorilla is more than twice as heavy as that of the bear. In the same way the brain of the horse (587 g.) is only $\frac{1}{443}$ of the total weight. In the whale, in which the enormous bulk is supplied by a brain weighing from 2000 to 7000 g., the disparity is still greater, being, in a certain definite case (a specimen of *Balaenoptera musculus*), 3636 g., roughly $\frac{1}{14000}$ of the total weight. This becomes still plainer when we compare animals of about the same total weight as, for example, the European hedgehog, the rabbit, and some small monkey, as the *Leontocebus rosalia*. The actual weights of the brain are, respectively, 3.4 g., 8.9 g. and 12.8 g., but the proportionate weights are $\frac{1}{219}$, $\frac{1}{116}$, and $\frac{1}{26}$.

In making a just comparison of this sort only adult animals must be taken in all cases, since the brain is always relatively large at birth, and thus in young and partly grown forms it is disproportionately heavy.

56. Comparison of Skull Shapes by Projections: Median Sagittal Plane. If any two anthropoid skulls, such as those of two allied species, or of different human races, be so placed that they are seen from exactly the same standpoint, a scientific basis for comparison is presented, and the similarities and differences will at once be

apparent. For such comparison the principal aspects are naturally (1) the full front (*norma frontalis*); (2) the profile (*norma lateralis*); (3) the rear view (*norma occipitalis*); (4) the view from the top (*norma verticalis*); (5) the view from beneath (*norma basilaris*). Seen from any one of these viewpoints the differences between the various Hominidae will at once strike the eye, and these general impressions can be accurately studied and measured by the help of projections of the outlines thus presented, drawn on paper by certain types of precision instruments.

The median curve of the profile view, *norma lateralis*, has thus far yielded the most, and is of great value in determining the relative position in development of the different forms. In this contour five important points are met with along the curve that limits the cranium, *nasion*, *glabella*, *bregma*, *lambda*, and *inion*. The *nasion* is the point where the curve is crossed by the nasal suture, the *bregma* the intersection of the coronal suture, and the *lambda* the superior point of the supra-occipital. *Glabella* and *inion* are the two noticeable projections, the one just above the nasion, the other below the middle of the occipital.

With these points established upon the profile projection curve the next to determine is the *glabella-inion line*, connecting the like-named points, and to erect upon this the longest perpendicular that can be included within the curve. This line is the *calvarial height line* of Schwalbe, and may be compared in skulls of different size by using the ratio of this line to the glabella-inion line considered as 100, i. e., the *calvarial height index*. This index, or ratio, is naturally small in a skull with a low dome, and large in one in which the dome is high. By connecting the lambda with the glabella, and erecting a similar perpendicular upon that the *lambda calvarial height* is obtained, which may be indexed in a similar way.[1]

[1] The measurement of the calvarial height and its accompanying index was first introduced by Schwalbe in 1899 in his important "Studien über

Furthermore, upon this same profile curve three important angles may be obtained and measured, far more exact than the facial angle of Petrus Camper, and equally significant for comparison. The *bregma angle,* i-gb-br, increases directly as the frontal bone is elevated; the *lambda angle,* gb-i-la, indicates the elevation of the occipital scale, and the *frontal angle,* formed by the intersection of the glabella-inion line with one drawn upward from the glabella and tangent to the most projecting point in the frontal outline, is a measure of the position of the forehead, whether retreating or bulging. All of these features thus serve in a general way as a criterion of intelligence, since they mark those anatomical relationships which are correlated with an increase in that part of the brain in which the higher psychic centers are located.

The following Table, extracted from a much more extensive one published by Schwalbe, gives the calvarial height index, and the bregma and frontal angles in a series of mammals, mainly Primates.

TABLE VIII. Comparison of Important Data Obtained from Median Profile Projections (Craniograms). After Schwalbe.

Designation of Specimen	Calvarial Height Index	Bregma Angle	Frontal Angle
Dog (*Canis familiaris*)	15	..	..
Cynocephalus babuin (*Papio cynocephalus*)	23.7	20.0°	33.0°
Ateleus vellerosus (male)	34.6	..	..
Cebus capuchinus	30.7	32.0	47.0

Pithecanthropus erectus; Zeitschr. f. Morphol. u. Anthropol. Bd. I., pp. 16–240. For the further use of this, cf. later papers by the same author (e.g., the "Sonderheft" of the same periodical, 1906, on the skulls of Brüx and Cannstatt), also Klaatsch, in Ergebn. der Anat. u. Entwick. Bd. XII, 1900. In the later practical application of the two height measures the nasion-inion line has been pretty generally substituted for the glabella-inion, owing to the frequent uncertainty concerning the exact position of the glabella. The results thus obtained are slightly larger than by the former method, but do not differ materially.

Semnopithecus maurus (*Pygathrix aurata*) (young)	36.9	32.0°	..
Macacus (*Pithecus*) *rhesus*	21.0	34.0	51.0°
Hylobates lar	21.9	..	..
Hylobates (*Syndactylus*) *syndactylus*	27.9	24.0	45.0
Hylobates leuciscus	30.5	19.0	32.5
Chimpanzee (male)	35.1	39.5	56.0
Chimpanzee (female)	29.6	33.0	56.0
Orang (female)	23.0	29.0	39.0
Gorilla (female)	18.7	..	20.0
Pithecanthropus	33.4[1]	41.0	52.5
Homo neandertalensis			
Neandertal	42.3	45.0	63.0
Spy I	40.5	46.0	58.0
Spy II	41.3	47.0	70.0
Homo sapiens			
Australian	53.9	60.3	89.0
Veddah	58.0	..	..
Kalmuk	54.5	56.5	85.2
Jagga negroes	59.8	..	..
Sioux Indians	58.8	..	..
Alsatian (male)	59.8	59.8	93.7
Alsatian (female)	59.8	58.6	100.3
Japanese	68.3	..	..

From this it appears that in general the three data taken all increase as the dome of the cranial cavity is lifted up, and that thus any one of them may be taken as an indication of the degree attained along this line of specialization. There are, however, some surprises, especially in the calvarial height index; for instance, the 21.9 of *Hylobates lar* and the 18.7 of the female gorilla. Such are incident to any table of indices, since the line taken as the standard, with an assumed value of 100, is as likely to vary as any other line, and if exceptionally long or short in a given case, the resulting index will be modified in the opposite direction. Thus in the case of the gorilla given in the table the calvarial

[1] 33.5 (DuBois); 34.2 (Schwalbe).

height, as shown by actual measurement, is fairly high and about the same as in the orang-utan, but when compared with an exceptionally long glabella-inion line (147 mm., as compared with 114 mm. for the orang-utan) the resulting index is small.

In the case of calvarial height measurements of heads of approximately the same size as those of the gorilla, the orang-utan, *Homo neandertalensis* and *H. sapiens,* the actual measure of the calvarial height in millimeters offers a fairer basis for comparison, and here also the record is plainly one of the gradual uplifting of the cranial roof. Thus, in three of the most famous skulls of *Homo neandertalensis;* Spy I, Neandertal, and Spy II, the figures for the *actual* cranial height are, respectively, 81, 84 (88, Schwalbe) and 87; while for the most ancient types of the present species the cranium is notably higher. Thus the Galley Hill cranium has a calvarial height of 97 mm., the "Old man of Cro-Magnon" one of 101, and that of Brünn 103. For the gorilla, with a skull in general larger than that of Man, the calvarial height measures 27.5 mm., the orang-utan 27, and the chimpanzee 38 to 48. *Pithecanthropus,* in this as in so many other respects, occupies a position intermediate between the species called "apes" and the lowest "men," its calvarial height measuring 60.5 (Klaatsch) or 62.0 (Schwalbe). Among recent men the actual figures for 23 Jaggar negroes vary from 84 to 115.5 mm., with an average of 100.3; and for 21 Alsatian males the cranial height varied from 94 to 115, with an average of 103. It will thus be seen that, in this respect at least, the skulls of Galley Hill, Cro-Magnon and Brünn come within the limits of variation, not merely of recent men, but of recent Europeans; while the Neandertal skull and the two Spys are beyond these limits, and plainly represent a distinct species, a little lower than *H. sapiens.* Much lower than these, and about intermediate between them and the highest apes, lies *Pithecanthropus.*

The new transition form from Africa, *Australopithecus,* is

evidently a little lower than *Pithecanthropus*, and nearer the direct line of human pedigree. A recent article by Broom[1] constructs a new phylogenetic tree in which *Australopithecus*, *Eoanthropus* and *Homo sapiens* lie along the main stem, while two lower side-branches give rise, the one to the orang-utan, and the other to the gorilla and chimpanzee. Above this follows on the main line *Australopithecus*, with *Pithecanthropus* on a third side-branch, arising near it. *Eoanthropus* follows next above *Australopithecus* on the main line, and after this follow two more lateral branches, the one with *Homo neandertalensis* and his close relative, also from Africa, *Homo rhodesiensis*, and the other with *Homo heidelbergensis*. Eventually comes *Homo sapiens*, at the top of the main branch.

57. The Tori Supraorbitales and other Structures above the Orbits. A certain amount of projection above the orbit and on its lateral side is characteristic of the Primate skull, and in some cases forms an exaggerated feature. This character reaches its extreme in *Tarsius*, where the orbit is built out for the support and protection of a pair of enormous eyeballs, themselves an adaptation to a nocturnal habit. *Tetonius*, also, shows this same character almost as exaggerated as in *Tarsius*, and on this account it may be presumed that this little Eocene Primate was also nocturnal, with large, staring eyes. From these examples it thus seems probable, as suggested above (§ 6), that the skull features under consideration were first acquired in adaptation to a nocturnal life.

As recently analyzed by Schwalbe[2] these characters consist of two separate projections, each in the form of an arch, the *arcus superciliaris* and the *arcus supraorbitalis*, the

[1] Broom, Robert. On the newly discovered South African man-ape. Natural History, a Journal of the American Museum of Natural History, July-August, 1925, pp. 406–418.

[2] Schwalbe, G. Studien über Pithecanthropus erectus. Zeits. für Morphol. u. Anthropol. Bd. I, 1899, pp. 16–240. 58 Figures and 3 Plates.

former medial and the latter lateral. In certain of the lower monkeys these two features are quite distinct, and are separated by an obliquely placed furrow, the *sulcus supra-orbitalis*, but in the simian apes in general there is a strong

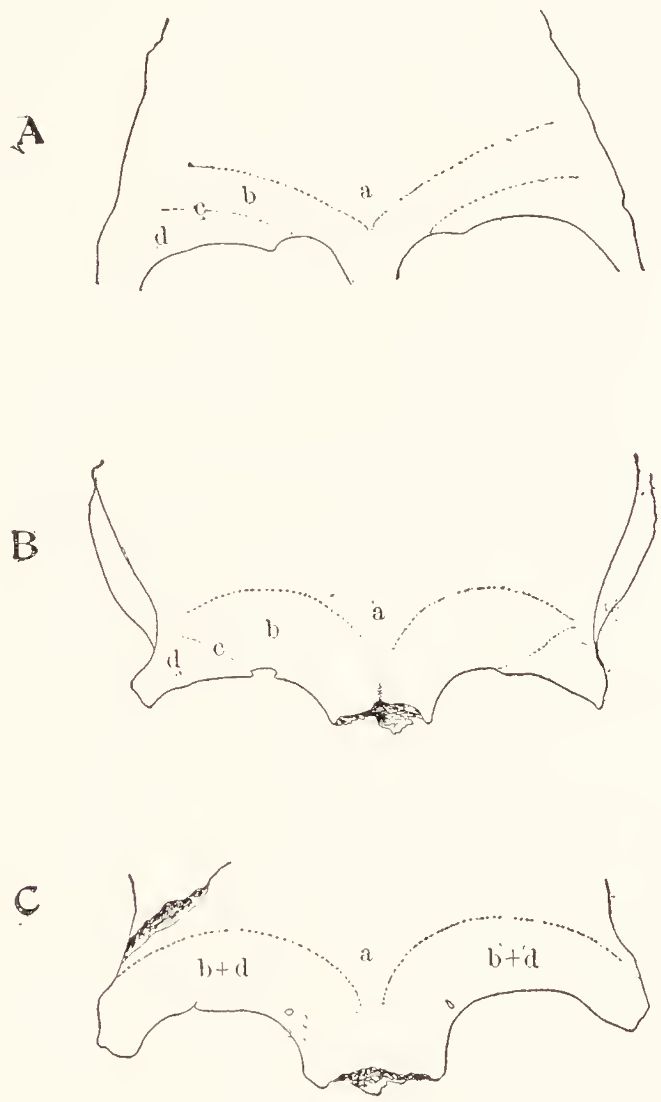


Fig. 77. Schwalbe's analysis of the frontal bone, showing the main features.

A. Frontal bone of *Cynocephalus mormon*, showing the features in primitive condition.

a, fossa supraglabularis; b, arcus superciliaris; c, sulcus supraorbitalis; d, arcus supraorbitalis. After Schwalbe.

B. Frontal bone of modern man (Alsatian).

C. Frontal bone of the Neandertal skull. In this the *arcus superciliaris* and the *arcus supraorbitalis* have fused, forming the characteristic *torus supraorbitalis*. After Schwalbe.

tendency for the two to become confluent, and also to unite across the middle line above the nose, and form a huge transverse ridge, the *torus supraorbitalis*. In such cases the cranial outline, as seen from above, presents an almost

straight front margin, which extends laterally further than any other part of the skull, except at the level of the ears. Just back of this line the cranial outline narrows rapidly, but expands again into a gentle curve as it defines the true cranial cavity. The lateral wings, that is, the parts contributed originally by the arcus supraorbitalis, are most pronounced in the gibbons; the tori as a whole are the heaviest in the gorilla, where they form a strong ridge, running across the median line, and contribute not a little to the fierce expression of the face. In the orang-utan both the tori and the wings are considerably reduced, the latter in apparent correlation to the narrowness of the entire skull, and the two lateral tori are not continued across the middle line, but are distinct from each other. In the chimpanzee these features are all rather moderate in size, but the tori meet across the middle line, as in the gorilla.

In modern Man there are never tori, that is, ridges formed by the fusion of the superciliary and supraorbital arches. The lateral elements, arcus supraorbitales, are practically wanting, and the inner ones, arcus superciliares, are at best a pair of moderately projecting, roughened surfaces, never confluent across the median line. Since, then, in all cases the ridge, even when noticeably projecting, consists of the inner element alone, it is morphologically not a torus.

In these brow features the extinct species, *Pithecanthropus erectus* and *Homo neandertalensis*, form a series of grades intermediate between the lower apes and modern man, and present a strong argument for placing the former in or very near the main line of development. In these the course of development seems to have been a reduction in the amount of forward projection over the eyes, combined with an increase in width, until, in the recent species, there is nothing left of the structure but a wide area projecting slightly forward, and lost above in the elevated forehead. Thus in *Pithecanthropus* the ridges are in the form of genuine, but thin, tori, that project far out over the eyes, almost as in the gibbon,

but in *Homo neandertalensis* they do not project so much, but are very thick and heavy, forming a striking feature of the skull, and probably also of the face when in the flesh. If, for example, as is extremely probable, this heavy torus was covered with a broad stripe of coarse hair, like an exaggerated confluent eyebrow, it must have given the face a defiant, and probably brutish, expression.

The effect of the lateral wings, in the living head, is much less noticeable than are the ridges, since the re-entrant angle formed in the outline of the skull when seen from the norma verticalis is at least partly filled by the temporalis muscle, so that, even when the hollow is really a deep one, the effect is only that seen in a very thin human being, with hollow temples. That is, when this hollow, produced by the configuration of the bony structure, is deep, it gives to a head the same effect as that produced in a modern man by emaciation, so that a normally nourished chimpanzee resembles in this particular a highly emaciated man. Probably the same thing was true of *Homo neandertalensis*, and, to a still greater degree, *Pithecanthropus*.

58. The Retreat of the Jaws. One of the distinguishing Primate characteristics, which has had much to do with molding the head into its characteristic shape, is the reduction in the length of the jaws and the consequent loss of the muzzle or snout, so common a characteristic, not of mammals only, but of Vertebrates in general. This reduction is undoubtedly due in some measure to the extensive use of fruits and grains as food, which do not demand heavy teeth, at least in the front portion of the jaw, but seems still more the result of the development of a hand, that great educator, which seizes objects of interest and presents them to the direct scrutiny of the eyes, nose and tongue, and thus relieves the muzzle of the duty of seeking out things for itself, as in other animals. It is true that some Primates, like the Cebidae, with jaws quite as much reduced as in the

rest, do not possess an opposable thumb, but even so they use their forepaws about as much as do the others, and employ them as constantly in grasping objects and bringing them before the face. It is this retreat of the jaws, quite as much as the advance of the forehead, which gives monkeys their flatness of face, and raises the facial angle so markedly in the higher species. In the highest forms, *Australopithecus*, *Pithecanthropus* and *Homo*, this jaw reduction is shown in progressive series, as in the case of the supraorbital tori and other features; and that the movement is still going on is shown by the marked differences among the living human races, for example, between the prognathous negroes and the members of the yellow race, with their flat faces.

The reduction of the jaws is closely correlated with a similar reduction in the size and completeness of development of the teeth; indeed, it is likely that the reduction of these latter precedes that of the jaws, and forms its immediate cause. Thus in Man the native Australians, who are probably the most primitive of living peoples, are also the most prognathous and have the largest and best formed teeth. In them the third molars ("wisdom teeth") are not degenerate, as so often with us, but are as strong and well-formed as the others. This condition in so primitive a race suggests that the force causing the reduction of the teeth is being exerted, in part at least, at the posterior end of the dental series, and that the weak and rudimentary condition of the third molars of Europeans is indicative of a further jaw reduction still going on.

A precisely similar development, the history of which has been so recent that the particulars are fully known, is the reduction of the jaw in the bull-terrier, especially in certain fancy breeds used as pets. In these animals this jaw reduction has been designedly brought about by artificial selection in the usual way, and is accompanied by a definite reduction in the size and strength of the teeth. Here, for some unknown reason, the upper jaw shows a tendency to retreat

faster than the lower one, and causes a frequent occurrence of the peculiar form of muzzle known as "undershot," in which the front teeth of the lower jaw project beyond those of the upper, and produce an imperfect approximation of the biting surfaces.

59. The Dental Arcade and its Proportions. The dental arcade, or dental arch, is the line formed by the row of upper teeth, and, as it closely follows the margin of the jaws, it presents its curve upon a practically plane surface, and thus furnishes a convenient means for the study of the proportions of this part of the skull. Long and narrow in

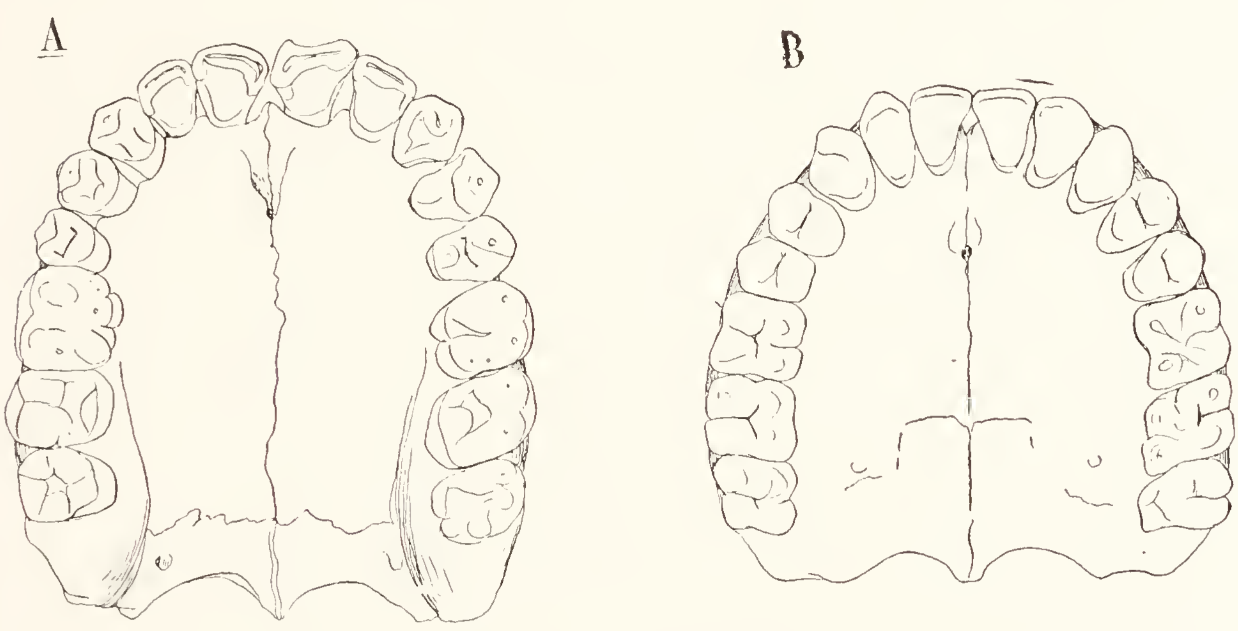


Fig. 78. Human dental arcades.
A. Inhabitant of New Britain. B. European.
After Adloff.

skulls with a projecting snout, it assumes broader and broader proportions as the jaw becomes more orthognathous, thus varying in shape between the two extremes of a long, narrow arch, to one almost in the form of a semicircle. Again, the form of the curved line itself admits of some variation, as seen especially in the direction taken by the lateral rows of cheek-teeth, which may be (1) straight or curved; or (2) anteriorly divergent, parallel, or convergent in respect to each other. The space included by the dental arch is

spanned by the hard palate, which terminates posteriorly approximately along the line connecting the free posterior ends of the arch, so that a measure of the dental arcade becomes at the same time one of the shape of the palate, and may be indifferently designated by either term.

The general proportions of this arch, whether long or short, are obtained by the obvious method of comparing the measure of the length and the breadth. The former is taken along the median line of the hard palate, between the inner wall of the alveolar processes and the median spine on the posterior margin; the latter is taken between the two second molars, with the termini at the inner walls of the alveolar processes. The index expressive of the proportions, termed the *palatal index*, is obtained by comparing the breadth with the length in the usual way, thus:—

$$\frac{\text{Palatal breadth x 100}}{\text{Palatal length}} = \text{Palatal index}$$

The resulting indices are naturally low in the case of narrow palates, and high in broad ones. In modern man it seldom falls below 70, and is arbitrarily divided into three groups, as follows:—

Index less than 80 . . . . narrow palate (leptostaphyline)
Index between 80 and 85 . . . . medium palate (mesostaphyline)
Index above 85 . . . . broad palate (brachystaphyline)

Naturally there is a direct relationship between these proportions and true prognathism, a prognathous skull being also leptostaphyline, and vice versa.

This study of the palatal proportions is of great importance in the examination of the remains of the various types of ape-men, since the progressive tendency to shorten the palate, and with it to change the shape and proportions of the tongue and soft palate, a tendency in which the orthognathous type of man has reached the extreme, brings with it a gradual increase in the power of producing differentiated articulate sounds, the physical basis of human speech. Even

in specimens in which the original alignment of the teeth has been lost, the form and proportions of the dental arcade may be obtained with some degree of accuracy through the length and breadth measurements of isolated teeth, especially those of the lateral rows, and from this the amount of ability in the production of articulate sounds calculated. Thus in the remains of *Pithecanthropus* the three teeth first found, the left upper second molar, the right upper third molar, and the left lower second premolar, suggest a dental arcade intermediate between that of the most orthognathous simian ape, the chimpanzee, and that of recent Man, and point to the conclusion that the animal had the ability to utter certain of the more elementary sounds employed in human speech. Thus Haeckel's name, *Pithecanthropus alalus* (the speechless) suggested for the hypothetical transition form, was manifestly unsafe to employ in its entirety for the Javan fossil, and the discoverer wisely substituted the specific name "*erectus*," thus emphasizing a character of which he was certain for one the applicability of which was at least doubtful.

Concerning the form taken by the dental arcade in the various Hominidae, the two rows of cheek-teeth form fairly straight lines, which are almost parallel in the chimpanzee, converge slightly posteriorly in the orang, and markedly so in the gorilla. In Man the lateral row shows a slight tendency to curve outwards in the middle, and bring the ends of the row, that is, the third molars, a little nearer together than are the others.

To obtain definite proportional values for the length differences in the lateral row of teeth, the cheek teeth, Flower[1] compared the sum of the maximum lengths (mesial-lateral) of the crowns of the five posterior teeth with the value of the cranio-facial axis (nasion-basion line) in the following way, considering the latter as the standard of comparison:

[1] Flower; in Journ. Anthrop. Inst., 1885. Employed by Duckworth in "Morphology and Anthropology," pp. 132–133, and 369–370.

$$\frac{\text{Sum of the crown lengths of premolars and molars x 100}}{\text{Nasion-basion line}}$$

In the living human races this *dental Index* was found to vary between about 40 and 45, and from this he classified humanity in accordance with the size of the teeth, as follows:

Microdont	(Index below 42)
Mesodont	(Index between 42 and 44)
Megadont	(Index above 44)

Europeans, Polynesians, and prehistoric Egyptians were thus found to be microdont; Chinese, American Indians, and African Negroes were mesodont; and Australians, Andamanese, and Melanesians were megadont.

Applying this dental index to the other hominids Duckworth obtained for *Hylobates* a value of 41.7; for the chimpanzee, 47.9; for the gorilla, 54.1; and for the orang-utan, 55.2. Of these the two first come within the human proportions, although it would seem that the line used as the standard, the nasion-basion line, must also vary proportionally. In all these tables, however, the correlation between the size of this row of teeth and the amount of prognathism is roughly apparent.

Naturally the curve taken by the lower teeth closely approximates that of the upper teeth, and thus in cases where either has been preserved the other may be restored. In the Heidelberg jaw (*H. heidelbergensis*) and the Piltdown skull (*Eoanthropus dawsoni*) the proportions of the missing upper jaw are well known in spite of the complete loss of the actual parts, and even in the case of *Pithecanthropus erectus* the dental arcade of both jaws is fairly well known from the teeth that have been found.

In studying and comparing lower jaws another character appears in all the lower Primates, and that is the extreme breadth of the ramus in all monkeys and apes, as contrasted with its narrowness in modern man. In this respect the Heidelberg jaw, which is all we have of a distinct human

species, exhibits a broad ramus, and in this respect is very apelike, "human teeth in an ape jaw." This to a slighter extent is seen in all the jaws of the Neandertal type, and must have been characteristic to a still greater extent of the unknown jaw of *Pithecanthropus.*

60. The Chin and the Neck. The term "chin," when used technically, applies to a feature which is not only exclusively a human character, but is found only in the recent species, *Homo sapiens.* It is thus not synonymous with the anterior contour of the lower jaw, but may be said to exist only when this contour, when taken in profile, projects forward from the plane formed by the anterior aspect of the lower teeth. This distinction may be readily seen by an instant's comparison of the skull of any anthropoid ape with that of a recent Man, and consists rather of the shape of the profile contour than of a projection of the entire jaw. In the ape the jaws are strongly prognathous, but the mandibular contour, seen in profile, drops back immediately from the base of the lower teeth, while in modern Man this contour is brought forward, or, at the least, does not recede. The ape is thus said to be chinless, although strongly prognathous; while in the most orthognathous human profile the chin may be, and usually is, well developed and prominent. Nearly every step in the acquirement of this extremely recent character may be followed in a selected series of prehistoric and recent human jaws, and, although the development of this feature is seen to have been a gradual one, it becomes a definite character only in the recent species and thus furnishes one of the best diagnostic differences between the two species of *Homo, H. neandertalensis* and *H. sapiens.* The men of Moustier and Spy were chinless; those of Cro-Magnon and Baoussé-roussé had chins.

It is a tempting thought to connect the formation of this definite feature with the gradual acquirement of human

speech, although there is much reason to think that a definite though simple language existed among the prehistoric chinless forms. Certain muscles of the tongue are

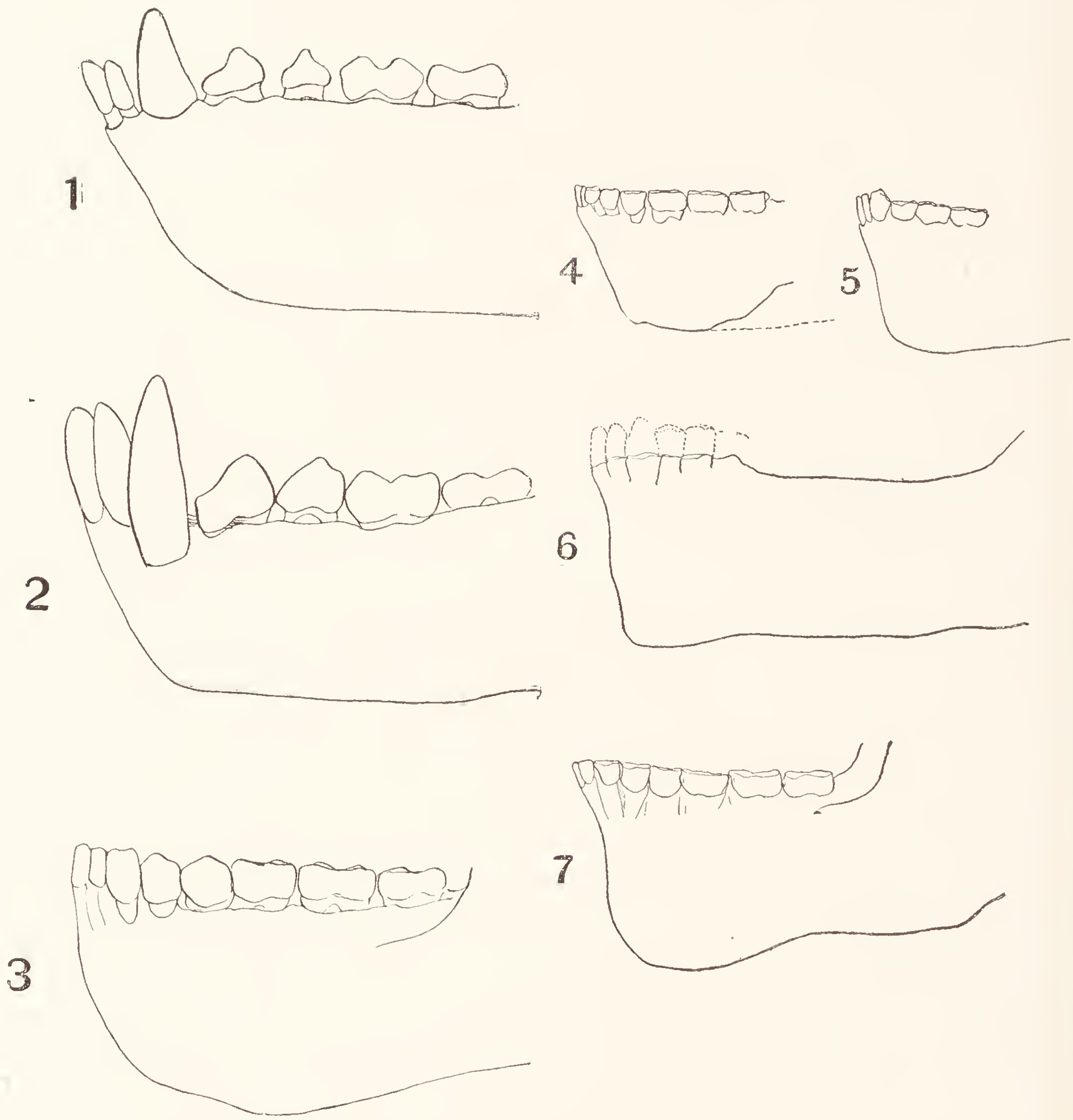


Fig. 79. Outlines of mandibles of Simian apes and early Man:—

1. Gorilla.
2. Orang-utan.
3. *Homo heidelbergensis.*
4. Krapina H.
5. Krapina I.
6. La Naulette.
7. Spy II.

attached to the inner side of the mandible opposite to the mental projection, and it has been argued that this part was developed, either directly or indirectly, by the traction

of these muscles in their employment in forming the articulate sounds, especially those connected with the tongue. These muscles, however, are not only no better developed in Man than in the other Hominidae, but also the tongue movements effected by them, such as protrusion and the depression of the point, have little to do with speaking, and play their chief rôle in the prehension of food, duties which are performed about equally, and in about the same way, by apes and men. The true cause for the formation of a chin must, then, be sought elsewhere, and may perhaps be found in the decrease in the size of the front teeth, with the corresponding recession of the alveolar processes. This recession and reduction of bone substance would naturally leave in relief the parts not directly affected, namely, the lower margin and the adjacent region. In old persons, in which the teeth have been lost, and where, consequently, the alveoli become still more reduced, the chin becomes proportionally more prominent than in middle life; in orthognathous races, also, in which the teeth are smaller than in the prognathous, the chin is more prominent.

Another theory that has been brought forward to account for the chin rests upon the presence of certain small bones, the *ossicula mentalia*, which appear during development, in the front of the mandible at the symphysis. These are known only in Man, and appear at about the eighth month of fetal life; they are from two to four in number, and, fusing with the two jaw halves and with each other, enter into the formation of the projecting ridge, *mental process*, of the adult mandible. These facts suggest at once the theory that the chin of Man is a late addition, formed from these elements, but it is altogether likely that these bones, the *ossicula mentalia*, are merely incident to the fusion of the jaws at the symphysis, like the similar ones that occur at certain of the sutures of the cranium (Wormian bones), and are hence without especial significance. They may thus be expected in the developing jaw of other Primates, although no one seems

to have found them or even looked for them as yet. If they have any significance in the formation of the human chin, it may be merely that their presence in some way modifies the shape of the portion left in relief by the recession of the alveolar portion.

It is to be supposed, then, that the human chin, the tendency to orthognathism, and the shape and proportions of the palate and tongue, are all of them phenomena depending upon the reduction in the size of the teeth, and that this, in its turn, results from the development and control of a hand capable of assisting the jaws in the preparation of the food. That among these modifications of tongue and palate certain proportions and relations have developed that have rendered articulate speech possible has been already commented on.[1]

Another striking though rather superficial difference between modern Man and his nearest simian allies lies in the configuration of the neck region. The graceful cylindrical column, which in Man is so definitely set off from the thorax below and the head above, appears in some apes to be quite wanting, and the head, with its small cranium and heavy jaws, is placed directly upon what seems like a bluntly tapering thorax. In front the contour line of the throat

[1] For the possible relation of chin and the *ossicula mentalia* to human speech, and for the general development of the chin, cf. the following:—

Adachi, B.; Ueber die Knöchelchen in der Symphyse des Unterkiefers. Zeitschr. f. Morphol. u. Anthropol., Bd. VII, 1904.

Fischer, E.; Beeinflusst der M. genioglossus durch seine Function beim Sprechen den Bau des Unterkiefers? Anat. Anz., Bd. 23, 1903, pp. 33–37. 1 pl.

Mies, J.; Ueber die Knöchelchen in der Symphyse des Unterkiefers vom neugeborenen Menschen. Anat. Anz., Bd. 8, 1893, pp. 361–365.

Toldt, C.; Die *Ossicula mentalia* und ihre Bedeutung für die Bildung des menschlichen Kinnes. Sitzungsber. der K. K. Acad. zu Wien. Math-Naturwissen. Klasse, 1905, pp. 1–36.

Walkhoff, O.; Der Unterkiefer der Anthropomorphen und des Menschen in seiner funktionellen Entwickelung und Gestalt. In Selenka's Menschenaffen, Bd. IV, 1902, and Bd. VI, 1903.

Walkhoff, O.; Die menschliche Sprache in ihrer Bedeutung für die functionelle Gestalt des Unterkiefers. Anat. Anz., Bd. 24, 1904, pp. 129–139.

extends straight from the edge of the jaw to the sternum, and in the nape the massive muscles fill up the entire space between the occiput and the shoulders.

The causes of this difference are many and their interrelations are intricate. In the first place the assumption of the completely erect position places the head upon the top of the vertebral column, and the reduction in weight in the jaws and teeth, together with an added weight of brain in the back of the head, puts the point of support almost under the center of gravity, thus relieving the nuchal muscles of the strain of holding up the head. Correspondingly these parts become reduced, and give a concave outline to the nape, especially when compared with the larger cranial contour. As for the front of the neck, the general reduction in muscular development, such as is seen over the entire frame, the result of the employment of tools and the use of mechanical means of gaining power, reduces, among other parts, the caliber of the neck, and produces a conspicuous reentrant curve, from which the larynx alone may project. This effect is further heightened by the development of a projecting chin, which sharply differentiates head and neck from each other.

61. The Features of the Face. Of all the facial features the mouth and nose are the ones most responsible for the difference of expression between the apes and Man. In the simian apes the nose presents scarcely any elevation above the level of the face, and in the skull the nasal bones are almost or quite rudimentary, and are often fused into a single piece in the shape of a narrow triangle, entirely unable to produce such an external elevation as the "bridge" of the human nose. In human races with very flat noses there is occasionally found a similar rudimentary condition of the nasal bones, approaching the condition found in these apes, but in general the nasal bones of Man are fairly prominent. The nostrils of the apes are very large and face forward, so that they often appear as large holes,

flush with the surface of the face; but even in the most apelike Men of modern times, the nose presents a considerable elevation, which tends to conceal the nostrils and direct them downwards, a tendency which becomes more marked the larger and more prominent the nose.

Curiously enough the recently discovered skull of La Chapelle-aux-Saints, a typical representative of *Homo neandertalensis*, possesses unusually large nasal bones, with marked forward projections, so that, in the flesh, the nose must have been large and prominent, and with a well formed bridge defining a noticeable angle in the profile contour. This is much at variance with the former ideas concerning this species, which, in all attempted reconstructions, has been furnished with a flat nose, something as in the apes.

The lips in the hominid apes, as also in the lower monkeys, are very thin, and are not noticeably thickened at their free edges, which meet in approximately a straight line, horizontally across the jaws; in Man the free edges are always thickened, in some races noticeably so, and the mucous surface is rolled out, or everted, upon the face, the amount of this eversion being proportional to the degree of thickness attained by the free margin. As both of these peculiarities are especially human, and away from the apes, the negro race, in which they are the most strongly marked, is in this particular higher, that is, more specialized, than the other human races, while the white race is the most primitive. Two dimensions of the mouth and lips, (1) the width, or length, up and down, of the upper lip and (2) the lateral extent of the mouth aperture, are directly dependent upon the configuration of the underlying hard parts, especially the teeth. In cases where these latter are large, as in the male gorilla or orang-utan, there is a definite rounded projection of the front of the upper jaw, the part covered by the upper lip, formed by the large alveolar processes. The lip naturally assumes the shape of this projection, although it is free from it, and in cases in which the projection is very

large, the upper lip becomes a wide flap, freely movable over the rounded surface, and used extensively in feeding, and in all activities in which the mouth is called into play. In all races of men this maxillary or alveolar projection is much reduced from its condition in the apes, and hence the upper lip never shows such a degree of development, although in a very prognathous face suggestions of it are apparent, as may frequently be observed in negroes.

The width of the oral aperture seems to be in proportion to the length of the dental arcade, since, in the resting state, the limits of the aperture are about opposite the first premolars. Hence, the aperture is wide in the apes, and comparatively narrow in Man. In the latter species a wide mouth is found in prognathous races with large teeth (*macrodont*), and a narrow mouth in those with the opposite character (*microdont*).[1]

In contrast to the nose and mouth the eyes show but little change in passing from the apes to Man. The upper eyelid in the apes is somewhat heavier and more drooping than is general in Man, and the heavy superciliary ridges, accented in the males, make the eyes deep-set and are inclined to render the expression ferocious. In the orang-utan the eyes are very near together, corresponding to the narrowness of the face in general, but in the chimpanzee and gorilla the distance is about as in Man.

The cheek bones are rather high and inclined to be prominent in the hominid apes, but this is also a characteristic of certain human races, and to as great an extent. The projecting jaws of the apes, the large size of the biting muscles, and the lowness of the forehead, give the face as a whole a

[1] These statements concerning the relation of the oral orifice to the underlying parts rest upon only a few observations, and are hence given with some hesitation. The whole matter, including both man and the apes, should become the subject of careful study, as it has scarcely been noticed up to the present time. Concerning the relation of the oral slit to the edges of the teeth horizontally it may only be said that in man it seems that the former lies slightly above the latter, but whether this is constantly so or not, or whether there may be racial differences, is not known.

shape unlike that of Man, but in proportion as these characters are softened, as in a female chimpanzee for example, the face becomes flatter and its general contour more man-like.

The ears are similar in shape in all the Hominidae, but differ in size. Those of the chimpanzee are the largest; those of the orang-utan the smallest; and those of Man are about an average between them. In all species the outer edges are rolled in from the upper limit of the margin nearly to the lobule, a process that takes place during late fetal life, and is often not quite completed at birth. As worked out by Darwin in the case of Man, and equally applicable to all the Hominidae, the early fetal ear has a flat free edge, with a slight point at the upper outer angle. The rolling in of this edge begins above, where the flap joins the head, and gradually spreads along the margin, causing the point rudiment, which originally points outwards, to change its direction, and point inwards and a little downwards, towards the meatus. This point in occasional human ears, the "Darwinian point," may be very conspicuous, and in all cases can be felt as a local thickening of the rolled margin. Infants are also occasionally born with the rolled portion of the margin very short and the region of the point still flat.

This rolling over of the margin, and the consequent general shape of the ear, is similar in all the Hominidae, and is continued quite as far in the lower members of the Family as in Man.

62. The Hair. One of the most apparent differences between Man and the apes, even the otherwise closely related simians, lies in the fact that the latter are clothed with hair, while Man is practically naked. This difference, however, although important, is merely one of degree and loses much of its abruptness on closer inspection; for while, the human body is clothed with rudimentary, though

still demonstrable, hairs, the hair of the apes hangs in sparse, matted masses from certain regions only, leaving large areas quite or nearly as bare as in Man. Thus in the orang-utan and gorilla the chest, the front of the abdomen, and the inner, or ventral sides of the arms and legs, often possess only a few straggling hairs, but these bare areas are generally concealed by the coarse masses which cover the back and shoulders, and hang from the dorsal sides of the limbs.

The advanced human fetus, at about the seventh month, becomes quite covered with a coat of fine down, the *lanugo*, which, in some cases, gives the specimen the appearance of a hairy animal. This degenerates for the most part before birth, but is often retained for a time upon the crown of the head, where it remains until displaced by the growth of the permanent hair over the same area. Traces of it remain also throughout life upon the cheeks, where it may be easily seen in a cross light, producing the so-called "bloom," well shown in females.

Man also differs racially in the extent to which the hair is developed. The Mongolians, Malays, and Negroes are among the most hairless, while the greatest amount of hairiness is found in members of the Caucasian race, and in a few scattered peoples, like the Ainus of Northern Japan, which are probably proto-Caucasic. In the Caucasian race there is much individual difference in respect to the amount of hairiness, or *pilosity*, some men being quite fully clothed with long and wavy hairs, that stand out from the skin, while others possess straight, short hairs, lying flat upon the surface. Men are in general more hairy than women. There seems to be a rather definite law of distribution of the hairy surfaces, which, in the case of the limbs, show a general correspondence to the areas of profuse hairiness in the simian apes; that is, upon the dorsal and outer aspects. Upon the trunk, however, the comparison does not continue, since the apes possess long hair on the back and shoulders, while the

chest is nearly bare, and in Man the reverse is apt to be the case, the back and shoulders being bare, while the chest and abdomen are apt to be covered with a broad ventral stripe of hair. This change in the haired areas may be correlated with the change from the crouching to the erect position, which exposes the back to the sun in the one case, and the chest and abdomen in the other.

The direction of growth taken by the hair in the various regions of the body is of much importance, and has been made the subject of considerable study. The hair is seen to form definite streams or currents, symmetrical upon the two sides for the most part, with definite boundaries where two opposing streams come together. There are also in definite localities peculiar features, known as *vortices*, *rhomboids*, etc., some of which seem to have some correspondence to the underlying bones and muscles, or to features of the development. The hair direction varies somewhat in the different groups of mammals, but there is a close correspondence in this regard between Man and the apes. A noticeable difference between the two, however, is seen in the direction of the hair on the forearms, which in the apes runs diagonally up the arm, and meets the counter current from the upper arm in such a way as to form a projecting tuft at the elbow, while in Man the hair on the forearm continues the direction on the upper arm, and the elbow is without a tuft. This peculiar reversal of the current on the forearm of the apes was accounted for by Darwin from the habit of sleeping with the arms covering the head to protect it from the tropical rains. The hair of the forearms, exposed to the torrents of water flowing from the wrists to the elbows, has eventually taken permanently the direction which it was thus forced temporarily to assume.

Other external influences have been employed to account for the hair direction elsewhere, and in other mammals, such as the traction of underlying muscles, the forces of gravitation and the wind or water currents, methods of

cleaning the coat, and, in Man, the influence of clothing and special habits, but a further inquiry into this interesting and prolific field would take us too far. Suffice it to say that all the explanations thus far have been along Lamonckian lines, and that in the hair direction is presented a potent series of arguments in behalf of the inheritance of acquired characteristics.[1]

The face and its surroundings are in all the Primates the seat of especial modifications in the distribution of the hair. Generally speaking the face, including the nose, the cheeks and the forehead, is bare, or covered merely with a remnant of the lanugo. In contrast to this the surrounding parts are adorned with tufts and fringes of hair of unusual length or texture, often of a different color from the rest. A very ancient character of this sort takes the form of a fringe of whiskers around the lower part of the face from ear to ear around the throat. In some cases, too, the remaining facial margin, over the top of the forehead, is also marked by a projecting fringe of hair, and the superciliary region is accented by either a low ridge of hair, as in the

[1] The subject of Hair direction possesses, historically, two periods of development, the classical studies of Eschricht and Voigt, respectively in the years 1837 and 1857, and the modern revival of the subject by Kidd, Friedenthal, and Schwalbe, since the beginning of the present century. During the long interval between we have only the investigations of Ecker on the sacral vortex, and the speculations of Charles Darwin. The titles of these papers follows:

Eschricht; Ueber die Richtung der Haare am menschlichen Körper. Archiv. f. Anat. u. Physiol., 1837, pp. 37–62. 3 pls.

Ecker, A.; Der Steisshaarwirbel (vertex coccygeus), etc. Archiv. f. Anthrop. Bd. XII, 1879, pp. 129–155. 12 text-figs. 2 pls.

Voigt, C. H.; Abhandlung über die Richtung der Haare am menschlichen Körper. Denkschr. der K. K. Acad. zu Wien, 1857, pp. 1–50. 2 pls.

Kidd, W.; Use Inheritance, illustrated by the Direction of Hair on the Bodies of Animals. London, A. and C. Black, 1901.

Kidd, W.; The Direction of Hair in Animals and Man. London, Black, 1903.

Friedenthal; Beiträge zur Naturgeschichte des Menschen. Jena, 1908.

Schwalbe, G.; Ueber die Richtung der Haare bei den Affenembryonen; in Selenka's Menschenaffen. 10te Lief., 1911, pp. 1–205. 13 pls.

eyebrows of Man, or by a projecting tuft, often highly colored and very conspicuous.

In the Hominidae the face is in part bare, but with certain special hair features, more apt to appear in males. In male orang-utans the outer region of the upper lip sometimes develops a patch of long hairs, which may even develop into a definite mustache, interrupted, however, in the middle. In the majority of human races there is but a slight tendency towards the development of a beard, but in races otherwise hairy a beard is the rule. This feature, when fully developed, covers the entire lower part of the face, as far up as the cheek bones, leaving bare only the surroundings of the eyes and ears, the nose and the forehead. In the lateral regions of the chin, also, just below the lip, the hair is inclined to be sparse, and is sometimes wanting.

The great development of hair over the cranium, as well as the localized tufts in the axillary and pubic regions, are specifically human, but in some races (e. g., Malay) these latter are often but slightly developed. In the related apes the cranium, though well covered, is not different in this respect from other hairy areas, and the axilla is often free from hair.

63. Hands and Feet. It is safe to assume that the primates have descended from terrestrial Vertebrates possessed of two pairs of five-toed feet, fitted for walking upon the surface of the ground. The assumption of an arboreal life, perhaps soon after the development of the dicotyledonous trees, that offered increased advantages for climbing, has modified these paws in various ways, transforming them to grasping or climbing organs. The projecting walking pads, which in the terrestrial type of paw are eleven in number, and cover the palmar and plantar contact surfaces, become reduced to approximately a general level; the digits become long, and in some cases curved; the claws become flattened out to form nails; and the first, or inner, digit

becomes separated from the others by a wide interval, and is eventually capable of being swung around so as to grasp a branch along the side opposite to that embraced by the other digits, thus holding it as between the jaws of a pair of forceps.

This opposability of the first digit is shown in its greatest perfection among the Lemuroidea, where in many cases the thumb and great toe (*pollex* and *hallux*) become so enormously

FIG. 80. Foot (hind) of a lemuroid, *Galago*, showing a typical prehensile paw, with opposable first digit. The second digit, as in the hind foot of all lemurs, bears a claw, the others nails.

developed that they are almost as wide and heavy as the remaining four, and become swung around so far that they lie in line with the others, pointing in an opposite direction. Moreover the entire paw is set at an angle with the rest of the limb and is so arranged as to close up automatically by the action of the weight of the body upon the muscles, somewhat as in the case of perching birds. In the Anthropoidea this character is not so specialized, and in a few cases is not even present in the case of both fore and hind feet. Thus in the Callithricidae, the little "marmosets" of South America,

the thumb is in line with the other digits, and shows no power of opposability, while the great toe, though small, is opposable. This latter digit also bears a flat nail, while all the other digits, or both fore and hind feet, are furnished

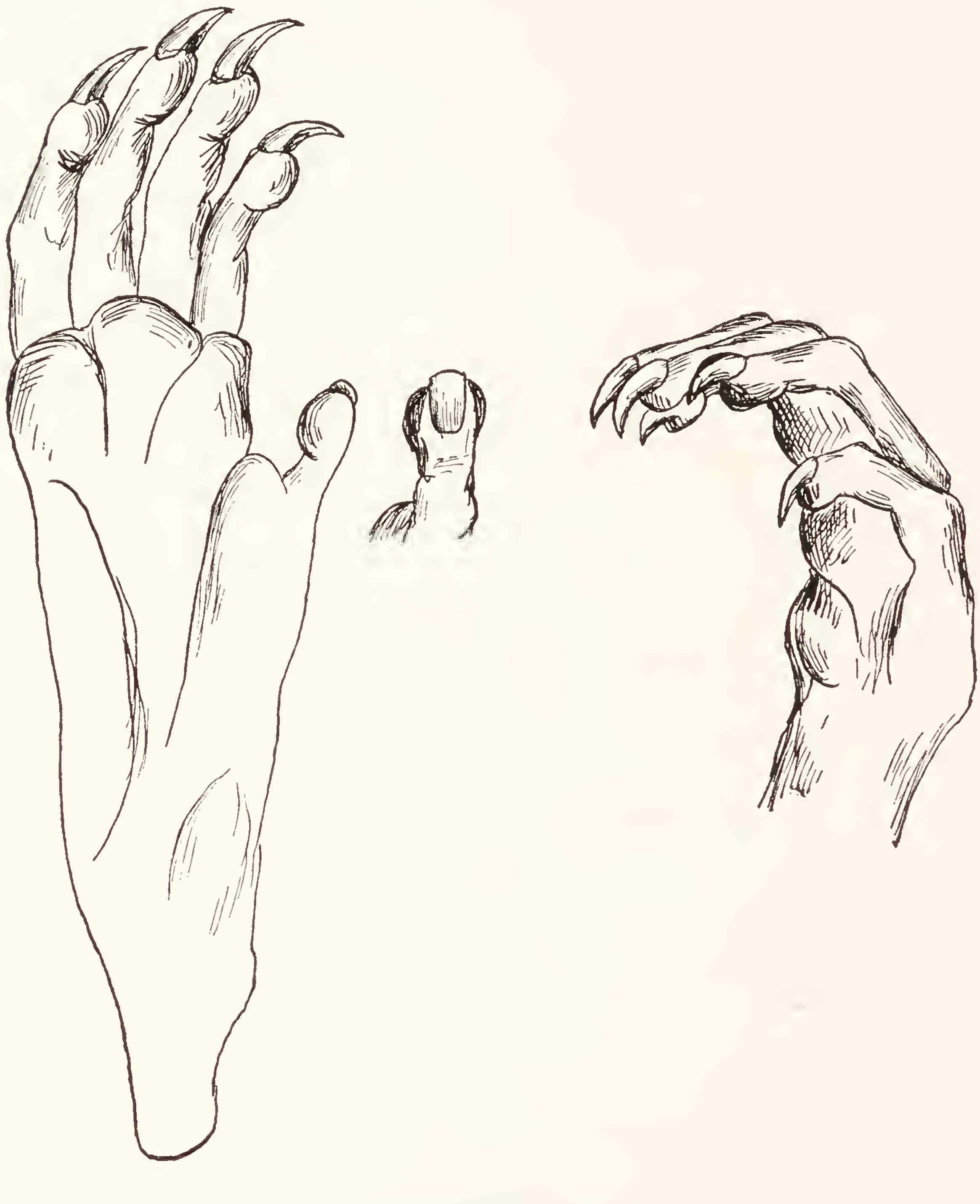


Fig. 81. Hind and fore foot of a marmoset, *Callithrix*. All the digits bear claws except the first one of the hind foot, which bears a typical flat nail.

with narrow tapering claws. In the Cebidae, which include the remainder of the New World monkeys, the hallux is always opposable, but the pollex, although opposable when present, is frequently wanting. In the Lasiopygidae both pollex and hallux are opposable, but the former is

rudimentary in the genus *Colobus*, the so-called "thumbless monkeys" of the African continent, which are closely related to the Asiatic genus *Pygathrix*.

Among the Hominidae, with the exception of the foot in Man, all the members, both feet and hands, possess a typical opposable first digit, and can be readily used for grasping. When standing or walking upon the ground, however, these hand-like posterior members, set obliquely to the axis of the leg, and with the four outer digits permanently curved, are at a disadvantage, and support the body upon the knuckles, the outer edges, and other surfaces not primarily intended for such a function. We must assume, however, from indications furnished by the structure and use, especially in the infant, that Man's immediate ancestor was possessed of just such an awkward foot, and that the present human form is a recent, and in the main a successful, adaptation of this to both standing and walking upon the surface of the ground.

It remains, then, for us to find out just how this adaptation took place, but in this speculation there is as yet nothing to guide us except the indications from structure and development. The bones of the feet and hands are, for many reasons, extremely likely to be missing from an excavated skeleton, and, with the exception of a few isolated foot bones from the Krapina find, and something from La Chapelle-aux-Saints, there seem to be no remains of the feet, even of our nearest relative, *Homo neandertalensis*. Of either foot or hand, older forms, like *Homo heidelbergensis* or *Pithecanthropus erectus*, there is not a trace. Structure and development, however, furnish some assistance, a very suggestive object being the foot of a young child, especially after birth.

In such an infant the feet are habitually held with the soles facing downwards and inwards, quite as in the apes, and commonly come to rest with the two soles applied to each other, a position which, with the changes of proportion in the legs during later development, becomes increasingly difficult to assume. During the first essays at standing or walking

the feet tend constantly to roll over inwards, a tendency increased by the natural bowing outwards of the legs, again an ape-like character. Later on this tendency becomes largely but not wholly corrected, yet in the adult, as is readily seen by the study of the prints made by a naked foot, the

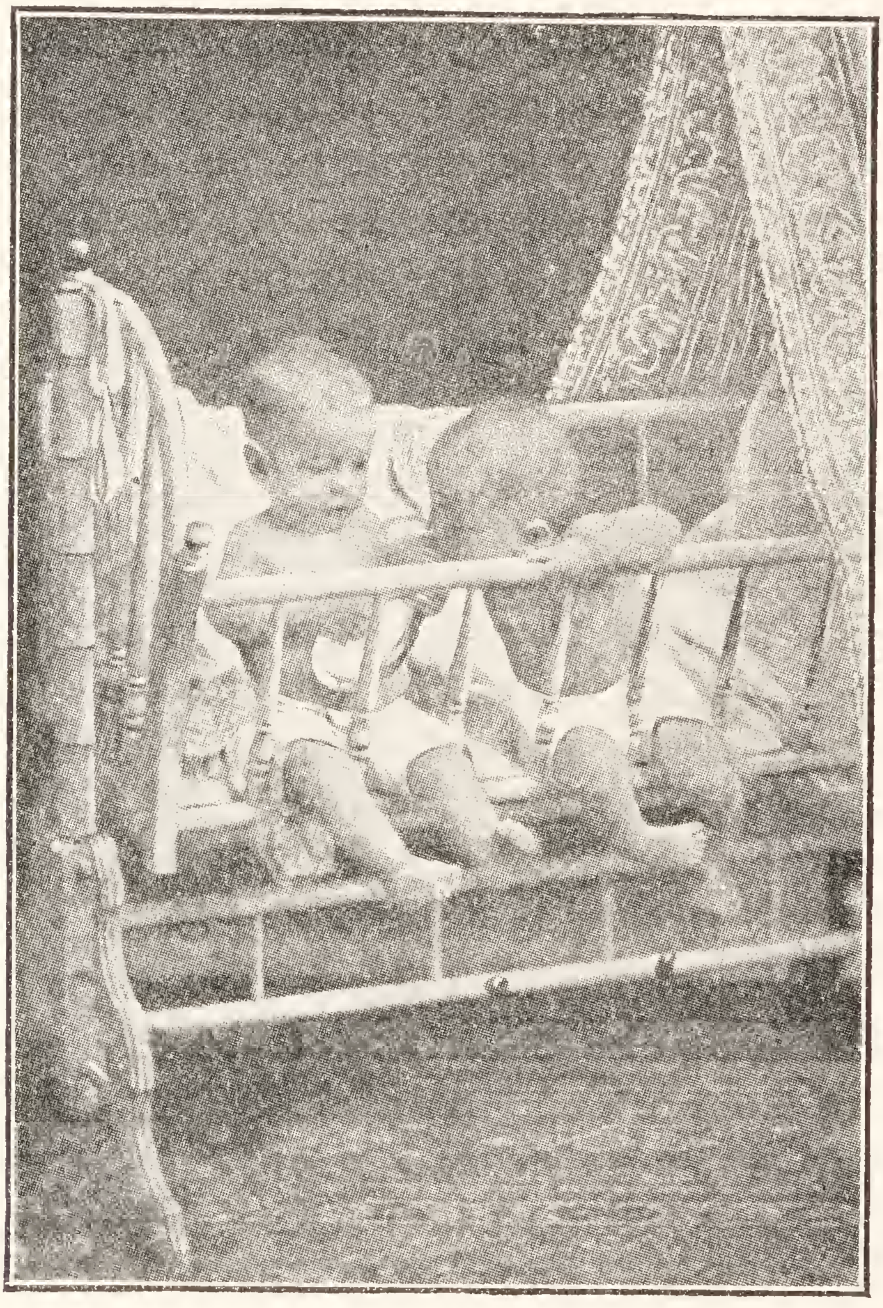


FIG. 82. Photograph of twin human infants, at the stage when the feet are used in a genuine Simian way. Used as an advertisement for an infant food, and consequently with no intentional posing. The block for this was loaned the author by the courtesy of the Nestlé's Food Co.

weight is habitually borne, not by the entire sole, but by the ball, the heel, and the outer edge. The structural response to the attempt of Man to turn the foot inwards, and thus come to use the whole sole, is shown, among other

things, by the detachment of an independent slip from the tendon of the *extensor digitorum longus* muscle, upon its outer side, which becomes inserted into the base of the fifth metatarsal, and is known as the "*Peronaeus tertius.*" This muscle, which becomes nearly or quite independent of its parent muscle by the separation of its belly in a proximal direction, exerts a constant upward pull upon the outer edge of the foot, and tends to bring the whole sole down upon the ground.

Again, in the infant's foot the four lesser toes are usually held in a flexed position, while the hallux, at first very large in proportion to the others, remains extended. This becomes significant when taken in connection with the use of the toes in the adult foot, in which the act of stepping, and especially that part of it which consists of sustaining the weight of the body upon the distal part of the foot, concerns mainly that portion designated by a line drawn from the projection of the heel to the point of the hallux, while the other toes are practically disregarded. In fact the human foot, both in structure and in use, emphasizes the hallux, and neglects the four outer digits, and shows definitely that the use of the foot during the lost transition period was one in which the bulk of the work was borne more and more by the former, and less and less by the latter.

With this point in mind we may now start with such a foot as that of the gorilla, and by studying its action while walking on the ground, ascertain its probable lines of development. The weight of the body is sustained upon the heel, the outer edge of the sole, the knuckles of the four outer digits, and the entire hallux, which latter is widely divaricated from the rest, and points inwards as well as forwards. Although short, this first digit is robust, and in the action of stepping, in which the heel is raised and the weight is thrown for a brief moment upon the toes, it is much better able to sustain the weight than are the four flexed ones. This constant use of the hallux to serve as a fulcrum upon which

the body rises at every step, together with the lack of employment of the other digits, which are merely held in a somewhat flexed position, and are in functional use mainly in tree-climbing, which we must assume is practiced with less and less frequency, naturally causes an increase in the size of the one and a decrease in that of the others. The hallux, at first divaricated from the rest of the toes, and pointed inwards, in seeking a more advantageous position for the exercise of its new function, naturally rotates forward, and lessens the distance, or interspace, between it and the others. By this means all five toes come to lie nearly parallel to one another, and as the hallux increases in length and thickness, it becomes eventually about as long as the rest, and far stronger and stouter. When, now, this point is reached, the foot is no longer a prehensile member like the hand, but a walking foot, almost as in modern man.

The final human form is reached by a few minor modifications, prominent among which is the decrease in length of the four outer toes. This process, plainly the effect of disuse, has already markedly affected the fifth digit, but the recency of this change is shown by the fact that in infants this toe is nearly as large as its neighbors. Aside from the reduction in size the degenerative process is shown in the frequent fusion of its two distal phalanges, a peculiarity found as frequently in the feet of habitually bare-footed races as in peoples that are customarily shod. This fusion is thus seen to be a true process of degeneration, and not the result of wearing shoes.[1]

[1] This matter of the possible course of development of the foot of modern man has recently received renewed attention. We wish to note here the following papers, which have recently appeared:—

Weidenreich, Franz; Der Menschenfuss. Zeitschr. für Morph. u. Anthrop. Bd. XXII.

Morton, D. J.; Evolution of the Human Foot. Amer. Journ. Phys. Anthrop. Jan.–Mar., 1924.

Wilder, H. H.; The Phylogeny of the Human Foot; the Testimony presented by the configuration of the Friction-Ridges. Zeitschr. für Morphol. u. Anthrop. Bd. XXIV, 1924.

64. Palms and Soles. Intimately connected with the previous discussion comes the comparison of the epidermic markings on the palmar and plantar surfaces, which reflect with great sensitiveness the changes in use and structure which have taken place. To begin with, the surfaces in question, in the case of a five-toed foot which has pre-

Fig. 83. Foot of a field-mouse (*Microtus*) showing the walking-pads and the enfolding folds of skin. After Miss Whipple.

served the original function of walking upon the surface of the ground, are covered with a series of walking pads, arranged in three transverse rows, and enclosed by folds of skin, as shown in Fig. 83, *Microtus*. To prevent slipping the contact surfaces of these pads become covered by epidermic ridges, which are arranged in transverse rows across the

pads if the animal simply walks along flat surfaces but tend to form concentric circles around them, to prevent slipping in any direction, if the animal becomes arboreal, and begins to grasp tree-boughs. This latter environment, however, tends at the same time to reduce the height of the pads, while, as more and more of the intervening surfaces come into direct contact with external surfaces, new ridges develop outside of and between the original ones, until, in the Anthropoidea, the entire palmar and plantar surfaces have become flat and covered with ridges. In accomplishing this, however, the arrangement of the ridges remains modified by the original pad and fold relief, and thus, when the entire area becomes reduced to approximately a flat surface, the ridges with which it is covered still indicate by their arrangement the original condition (Fig. 84, *Pithecus*). Thus, where the rounded walking pads occur in the foot of a mouse or hedgehog, there are to be seen, in the monkeys, systems of epidermic ridges arranged in the form of concentric circles, while the courses of the ridges that enclose these circular areas, reproduce with equal faithfulness the former folds of skin that enclosed the pads, and even their points of intersection are still plainly seen in the triradii, or points where three systems of ridges come together. The one is a three dimensional relief; the other is a flat picture of the relief.

The degree of constancy with which this original plan is retained in the disposition of the ridges in the palms and soles of the lower monkeys, together with the coarseness and firmness in the ridges themselves, leads one to think that here is not merely a survival of an early condition, but physiologically efficient organs, and that the course of the ridges over each definite elevation and depression is not wholly an inherited plan but that the special physiological needs of each spot are consulted in the adaptation. In fact the epidermic ridges are still seen in the smaller monkeys to continue the exercise of their original function, that of preventing slipping by interposing friction ("anti-skid" ridges), and the retention of

the early pattern is mainly due to the fact that this pattern is still what the animals especially require. In the Hominidae, however, in which the total body weight has increased, and where the paws have become so large that they encircle

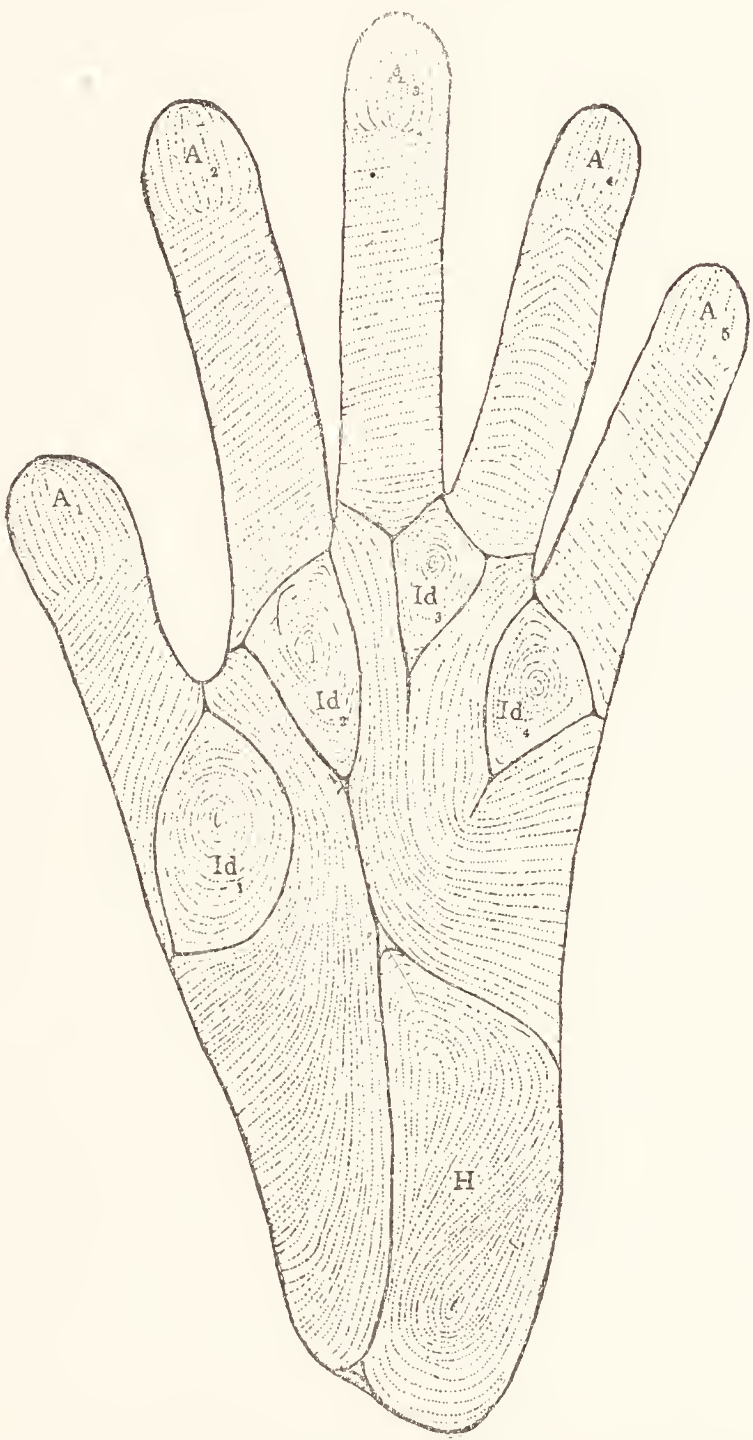


FIG. 84. Hand of a monkey (*Pithecus*), in which the entire surface has developed friction-ridges, the arrangement of which still indicates the original plan of the walking-pads with their surrounding folds of skin.
After Miss Whipple.

entire tree-boughs, and rely on the strength of the fingers, rather than on the friction produced by epidermic ridges, to prevent slipping, these ridges and their disposition become of less importance, and the patterns, with their enclosing

triradii, the marks of the former folds of skin, are allowed to degenerate.

Thus in the human hand it is extremely rare to find the typical eleven pad-patterns all present; more often certain of them are degenerate, and either furnish a slight suggestion of their position by a small loop, or are entirely replaced by a series of parallel ridges in which there is no indication of the former presence of a pattern. In this respect the lower races of humanity seem fully as much modified as the higher, and are no more likely to exhibit a more primitive arrangement. Thus the primitive palm here presented, in which all eleven pads are indicated, is from a boy of American parentage, from Portland, Maine; while the degenerate one (Fig. 85, *a*), with the palmar patterns nearly lost, is that of a Negrito from the island of Luzon.[1]

In regard to its future development, the human hand shows a strong tendency to have its ridges arranged in parallel lines, which run transversely across the palm, as if in adaptation to a comparatively new habit, that of holding cylindrical objects with the axis crossing the palm transversely. In this regard the right hand has progressed further than the left, since a much larger percentage of right hands than of lefts exhibit the arrangement of lines given in Fig. 85, *b*, a specimen in which the tendency has reached its extreme. Curiously enough a similar percentage for the occurrence of this type in the two hands holds good for Maya Indians, American Negroes, and Americans of European extraction.

In the human foot the four interdigital patterns, lying, as in the hand, just proximal to the intervals between the digits, are often all indicated, the first, corresponding to its important functional use, being nearly constant and disproportionately developed, and the others giving the appearance of being huddled together, and somewhat overcrowded

[1] Cf. Wilder, H. H.; Palm and Sole Studies. VIII, Occurrence of Primitive Patterns (Whorls). Biol. Bull., Sept. 1925.

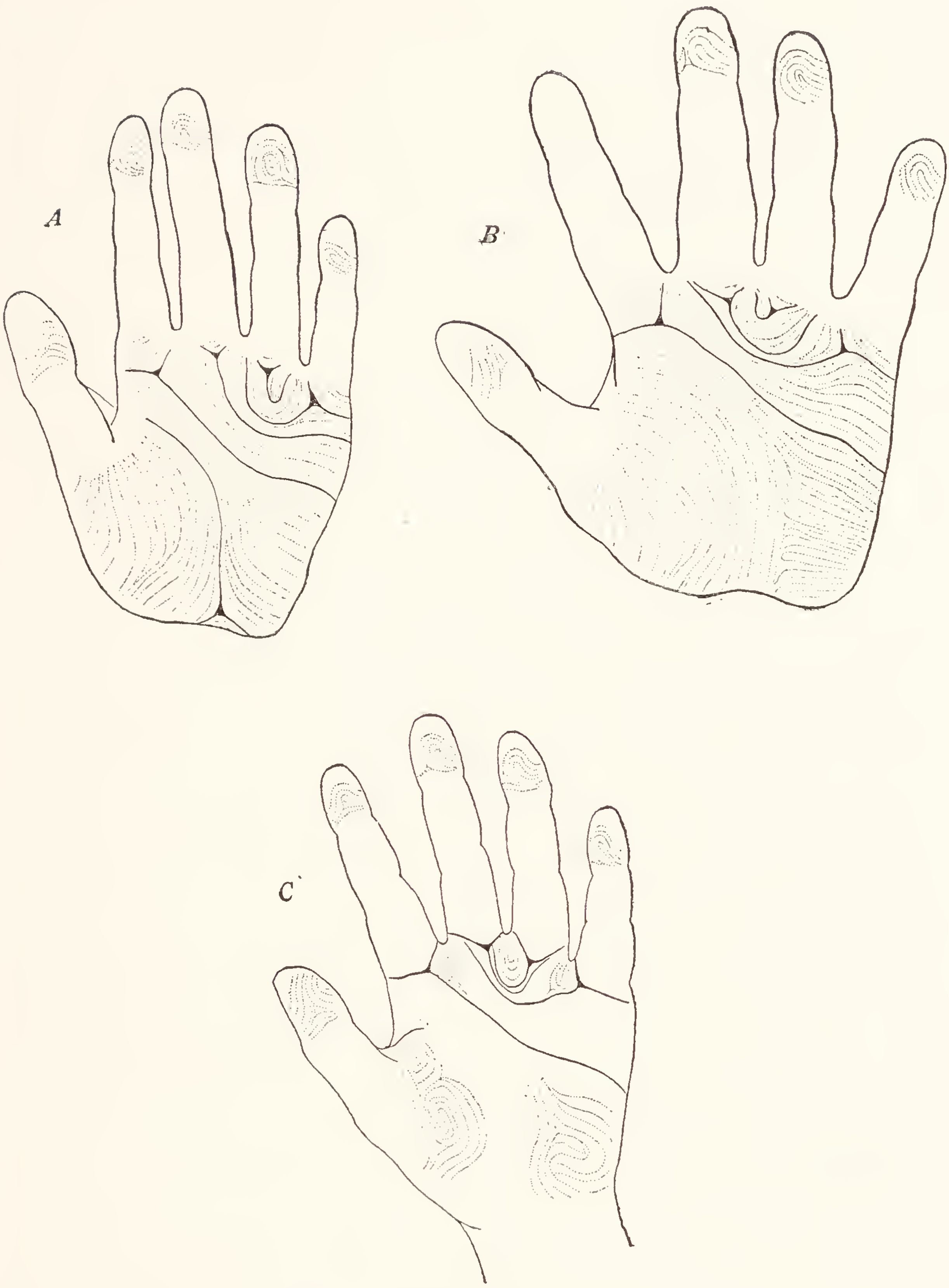


FIG. 85. Configuration of the epidermic ridges (friction-skin) upon the palm of the human hand.

a. Negrito, female. Island of Luzon. 18 years old. H. H. W. Coll. No. 479.

b. Maricopa Indian from Arizona. Male, 55 years old. H. H. W. Coll. No. 467.

c. American white, Portland, Me. Male, 12 years old. H. H. W. Coll. No. 409.

This result corresponds to the theoretical sketch of the development of the foot given in the preceding section, and shows plainly the tendency to place the weight along the line leading from the heel to the hallux, and reduce the four outer digits. Of the two proximal patterns, the thenar and the hypothenar, traces occur, especially of the latter, but their nearly complete suppression again seems the

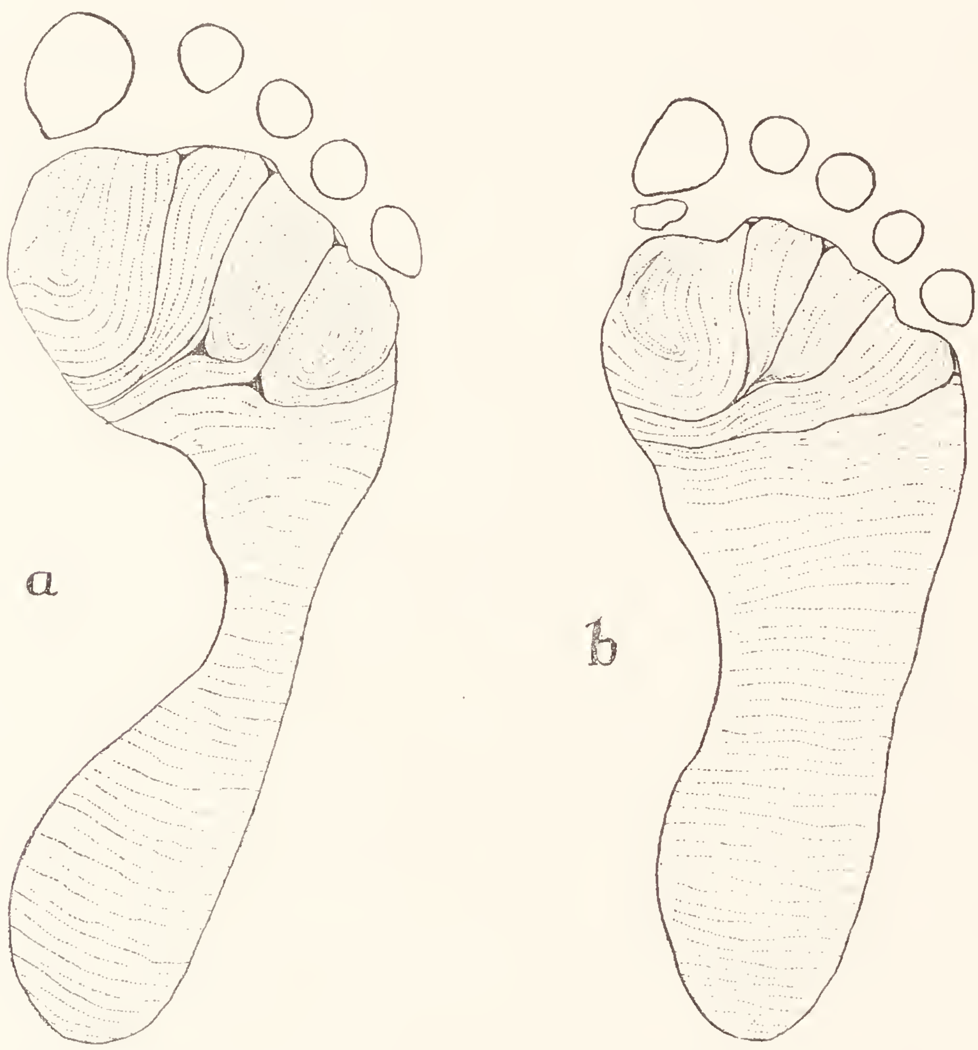


FIG. 86. Configuration of the epidermic ridges (friction-skin) upon the human sole.

a. Patagonian Indian. Male, 20 years old. H. H. W. Coll. No. 471.

b. Ainu. Female, 18 years old. H. H. W. Coll. No. 458.

result of the disuse of the surfaces upon which they are situated. The extensive backward prolongation characteristic of the foot is covered simply with transverse ridges, again at right angles to the habitual direction of motion against the surface of the ground, and hence calculated to produce an increase of friction and prevent slipping.

As in Man the other members of the Hominidae show individually a large degree of degeneration in the palmar and plantar patterns, but in this they seem to have followed other lines from Man, and the two are difficult to compare. As in Man, too, there is much individual variation among them, and there is cause for hope that in the future, when more data have been accumulated, the comparative study of these surfaces in all the apes may yield important light upon the interrelations of these forms to each other, and assist in pointing out the paths of development followed by each.[1]

65. The Attainment of the Erect Position. Primates are but poorly adapted to walking on the ground in the manner of other mammals, since, through their adaptation to an arboreal life, their pairs of legs have become of unequal length, while the terminal organs, the chiridia (hands and feet), long used for grasping, clinging, or

[1] The subject of the configuration of the epidermic relief upon the ventral surface of the mammalian paws, and the special course of the friction ridges in man was opened up during the '80's by A. A. Kollmann and Klaatsch. In the next decade came the work of Galton, confined to the finger tips, and that of Hepburn, with valuable suggestions concerning the mechanical bearing of the ridges. Since the opening of the present century there has been a wealth of material upon this subject, mainly by Schlaginhaufen, Kidd, Whipple, M. and Mme. Loth, and the present author. Among these may be cited the following:—

Whipple, Inez L.; The ventral surface of the mammalian chiridium, with special reference to the condition found in Man Zeitschr. f. Morph. u. Anthrop., Bd. VII, 1904, pp. 261–368.

Schlaginhaufen, O.; Das Hautleistensystem der Primatenplanta mit Berücksichtigung der Palma. Morph. Jahrb., Bd. 33, 1905, pp. 577–671, and Morph. Jahrb., Bd. 34, 1905–6, pp. 1–125.

Wilder, H. H.; Palms and Soles. Amer. Journ. Anat., Vol. I, pp. 423–441. (Several papers on racial differences in these particulars, in Amer. Anthropol., 1904 and 1913; also upon the use of the friction ridges for establishing personal identification, in Pop. Sci. Monthly, 1902 and 1903.)

Wilder, H. H., and Wentworth, Bert; Personal Identification. (Mainly a work for the police, on the subject of finger-prints, yet containing Chapters on Palms and Soles.) Badger, Boston, 1918.

Wilder, H. H.; Racial Differences in Palm and Sole Configuration; Japanese and Chinese. Amer. Journ. Phys. Anthropol., Vol. V, No. 2, 1922.

standing upon cylindrical tree-boughs, are at best but indifferently suited for walking feet. Being naturally a race of athletes, however, they encounter these difficulties nobly, and often attain considerable speed upon the surface of the ground. Some lemurs, and the anomalous *Tarsius*, balance themselves upon elongated hind legs, and cover the distance traversed by prodigious leaps, not even attempting the quadrupedal position; monkeys walk upon their palms and soles, but their long hind legs pitch them forward, and their heads are so awkwardly placed for this kind of gait that the faces are directed towards the ground, or held up by a conscious effort. The walk of the hominids, as has been described in detail above (§§ 14-17), includes a great variety of methods, but all are more or less awkward in appearance and become effective mainly through the great muscular power and superior agility of those that have devised them. The methods resemble those devised by muscular cripples for getting over the ground in the most practical way rather than the normal gait of an animal long adapted to such an environment.

Undoubtedly it is in the increase of weight so often characteristic of the later history of a successful race that we find the real cause for the descent from the trees and the reassumption of the terrestrial life manifested to a greater or less extent among all the apes, for with the attainment of a weight of perhaps a hundred pounds many of the customary actions of smaller animals become impossible, and with a bulk two or three times this a further arboreal life becomes impossible. Yet none of the Hominidae have altogether forsaken an arboreal life, and even in Man, the most terrestrial of all except perhaps the gorilla, it is easily reassumed, especially in youth and among primitive peoples. The orang-utan is perpetually in the trees, and is very ill at ease on the ground; the gibbons are perhaps the most perfect among all the Primates in their arboreal adaptations, and the chimpanzee, while about the best

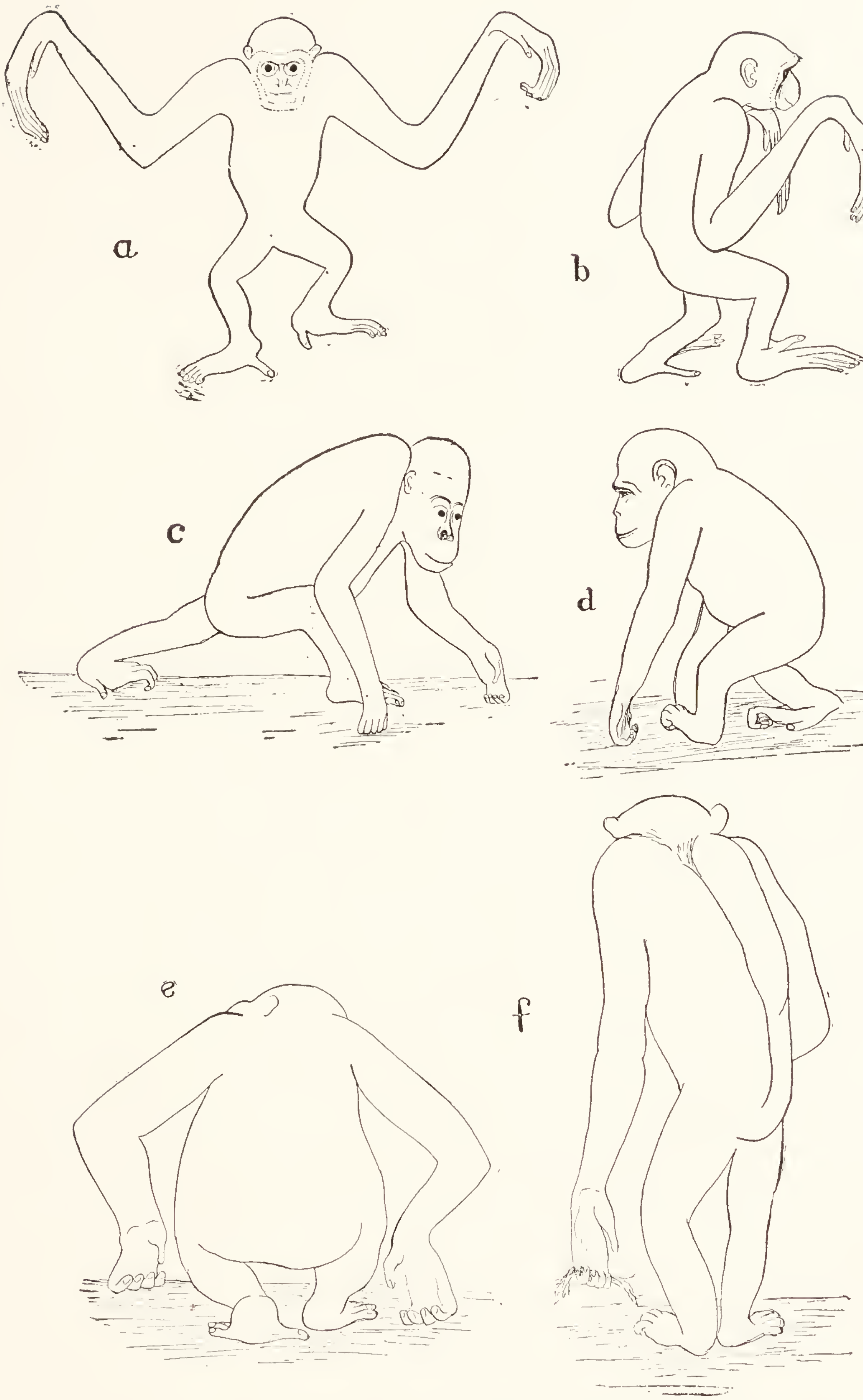


Fig. 87. Walking poses assumed by the apes. Outline sketches from Ranke, Der Mensch.

a and *b*. Gibbon. *c* and *d*. Orang-utan. *e* and *f*. Gorilla.

walker except man, lives mainly aloft. Only the gorilla and man are mainly terrestrial, the former plainly through necessity, as no tree could sustain with safety a large male. Yet even with these the adaptation is but a partial one, and the human infant, in its marvelous prehensile powers, and in the proportions and position of its legs and feet, is at birth definitely a tree climber, hardly fitted for the erect position.

This latter position, which so long served the old philosophers to separate Man from the brute, and in which they saw the special mark of Divine favor, is logically the only other position of comfortable equilibrium besides the quadrupedal, and becomes the necessary one for a mammal in which the two pairs of limbs are very unequal in length. Perhaps one factor in the attainment of the erect position by a member of the Hominidae has been the extreme lengthening of the arms, which has forced these animals, while running on all fours, to become partially erect, a position which the effort to hold the head up for the purpose of seeing has maintained. This cannot have been the case, however, with *Galago* and *Tarsius*, which are equally bipedal, and the main cause in both cases may be rather the attempt at a position in which the parts are well balanced.

Some have found the cause of the erect position in man the necessity for balancing and sustaining the heavy head, made so by the great increase in the brain, but as mechanical problems the tusks of the elephant and the horns of the moose or elk are fully as serious and they have been solved otherwise, the one by shortening the neck, and the other by strengthening the *ligamentum nuchae*. While, then, neither the long arms or the heavy head have been the primary causes for man's erectness, they may both have had importance in the adjustment of the problem. A deeper cause may lie in the fact that through the climbing habit the Primates from the first have accustomed their body to have its axis maintained for long intervals in or near a vertical position, and that thus the muscles of the body wall, and the

supporting ligaments of the organs, have become so adjusted to this position, that they no longer feel a strain during its assumption. Thus it is that it is assumed freely by the lemurs, that the lower forms, the monkeys, habitually sit erect, and that the simian apes can stand so readily upon their hind feet. Among these latter, however, the fore-limbs are never wholly emancipated from all participation in the act of walking; some swing the body through the supporting arch of the arms, as if walking with crutches, some rest the fore knuckles on the ground for steadiness, or grasp continually at objects beside or just above them, some clasp the hands about the back of the head, and even Man, after all his centuries of adaptation, makes constantly curious swinging motions with his fore-limbs. This action is not so apparent under conditions of extreme civilization, as, for example, when walking along perfectly smooth roads and sidewalks, but when going over rough country the arms are constantly in demand for such a purpose, and in a tangled forest an opportunity for assisting the progress by grasping a bough with the hands and swinging the body forward by this means is seldom lost.

Aside from the problems of readjusting the weight of the organs and of maintaining the equilibrium in the erect position there is still another one, localized, indeed, yet of much importance, namely, how to adapt the foot to a perpetual application to a flat, horizontal surface. To solve this the gibbon extends its toes in a straight line, and walks upon the entire plantar surface, including both the whole sole and the volar surfaces of the digits. This is similar to the method employed by terrestrial monkeys, like the Barbary ape, *Simia*, to which the gibbon is nearly related, and is rendered possible by the fact that, like them and unlike the orang-utan, its phalanges have not become curved, and its foot has not developed the oblique inward twist at the ankle caused in the larger species of apes by walking upon the sides of large cylindrical boughs.

In the case of the chimpanzee and the orang, however, these two last mentioned peculiarities are present, and these animals are compelled to bear their considerable weight upon feet obliquely twisted and permanently curved, organs which have become recently modified in the attempt to continue an arboreal life in spite of an increase of size. With such poorly adapted feet they are forced to use as contact surfaces the outer edges of the soles, the convex front margin of the same, opposite the row of metatarso-phalangeal articulations, and the distal ends of the digits, that is, the tips rather than the balls, precisely the parts which are emphasized as contact surfaces in the present day human foot. How the change came from one to the other, a change that does not require very much modification after all, in spite of apparent differences, has been already considered above. This way is well pointed out by the gorilla, which of all four Simian apes stands nearest to Man, and in which the significant point is the emphasis placed upon the hallux. This digit already at this stage stands out well from the other toes, pointing forwards and inwards, and forms a fulcral point, over which the foot turns at each step, precisely the use which would tend to develop the foot along a straight line leading from the heel to the end of the hallux, while the disuse of the other toes would reduce them, perhaps still in their curved position, to the form seen in Man.

With the final attainment of the fully erect position numerous anatomical modifications, already started or suggested in the bodies of the tree-climbing ancestors, become perfected. Already in the lower forms the need becomes felt for strengthening the pelvic floor, framed in by the hip-girdle, and preventing the abdominal viscera from pressing too heavily upon it, and in the apes this point of weakness in an erect animal is made strong by employing the tail muscles, no longer needed in their original capacity, to build a strong muscular wall across this gap. The head is finally adjusted so that it is almost equally balanced between

a tendency to drop forward and one to drop back, but with just enough weight in the jaws and teeth so that if left to itself it would follow the first inclination. It can thus be held up at the very slightest expense to the neck muscles, and the *ligamentum nuchae* can be practically dispensed with. The face, in its final attempt to keep its eyes facing forwards and not upwards, has bent the cranio-facial axis to its very limit, so that in the human head the back part of the palate is almost in contact with the medulla. Above this axis the brain, its original axis similarly modified, fills the cranial cavity compactly and symmetrically, the whole composing a homogeneous structure which reveals itself only to the comparative anatomist as the end of a long line of specialization, in its fundamental modifications of such parts as the eyes, the jaws, and the cranio-facial axis, probably the most daring attempt of Nature at an extreme adaptation.

66. Articulate Speech. Probably the most fundamental difference of physical structure and function between man and his nearest living allies is that of articulate speech, the power to form numerous vocal sounds well differentiated from each other and capable of endless combinations, to which arbitrary meanings may be attached so that the meaning or intention of the individual uttering the sounds may be understood in a definite way by those who hear him. Such a definition will hardly admit the instinctive cries uttered by the lower animals, for these come almost as a reflex response to certain stimuli, and plainly express only a general state or condition like the feeling of well-being, the hunger call, the sex call, the cry of fear or actual pain. Although it may be that in such responses the faculty of language took its rise, language is in itself far more than this, and even in its crudest form involves the representation of more definite conceptions on the part of both the speaker and the hearer.

In this sense, then, articulate speech seems hardly to have appeared among our present large apes, since their cries, although they appear to be differentiated in sound into a "vocabulary" of a dozen or a score of different "words," and although they seem to convey a general emotional meaning to their associates, they do not seem the result of a determined effort to communicate, but are as instinctive in their development and use as the bristling of the hair along a crest on the top of the head, or the gnashing of the teeth in time of threatened assault. For instance in recent studies of the gibbon in this particular it was found that the animal was certainly in possession of a small set of definite cries, distinct from each other, yet that every one of them developed spontaneously in a captive gibbon, taken from its mother when an infant, and raised in a French garden, away from all others of its race.[1] The words of this pseudo-language, divided into those of (1) well-being, or satisfaction, (2) discomfort or fear, (3) intermediate state, and (4) a song of joy (grand chant d'excitation), consisted of such sounds as these (transcribed by one whose native language is French):—

(1) Satisfaction:	Hoc hooc hoc, hoc houc houc, gouacgac, Couiiiii, Koui, hüg
(2) Discomfort:	Hoc, hoouc, koc, koug hiig, crucg, crenng
(3) Intermediate state:	Thuinng, hooooug̃ig, kouhig, prurrt

This spontaneous development of definite vocal cries in a gibbon removed from its birth from all association with its fellows shows clearly that we have not here to do with a true language in the human sense, for in this latter a set of sounds, often quite complex, is acquired by conscious imitation, and an arbitrary meaning is learned for each at the same time, while the cries of the gibbon are rather to be compared with the song of a bird, which will develop at the proper time in a captive, grown, or even incubated, away from others of its

[1] M. Boutan, in C. R. Acad. Sci. 4 Nov., 1912, reviewed in Biologica 15 Dec., 1912, p. 376. The animal experimented with was *Hylobates leucagenys* from Anam.

species. In such a case the song that develops is not that of the foster mother but that of the species to which the foundling belongs, in other words, a true instinct, depending upon an inherited arrangement of cells and connecting fibers in the central nervous system. It is, of course, quite out of the question to perform such an experiment upon a human infant, keeping it entirely out of hearing of human conversation until it has reached an age of six or seven years, but if this were done it is likely that that child would develop a series of vocal cries; yet it would be absurd to expect that it would ever spontaneously hit upon the sounds used in a given language or that it would attach to them the arbitrary meanings employed by any group of human beings. There would be no such duplication of the sounds employed by its race in general, as was actually the case with the gibbon.[1]

Although data concerning the cries, or the "vocabulary," of the other simian apes are very scanty, the evidence seems to show that the conditions are about as in the gibbon, that is, they consist of a series of vocal sounds, instinctively developed, and consequently the same in all, and that in these limited sounds there are only such very general meanings as comfort, discomfort, and various desires, threats, and fears. Furthermore, these general meanings are so helped out by attitude, gesture, and above all by facial expression, developed among the Hominidae to an exaggerated degree, that the main power of communication rests much more with these things than with the vocal utterance.

[1] Stories are not lacking concerning actual attempts at this very experiment here suggested, beginning with the one recorded by Herodotus of Psammetichus, King of Egypt. Many of these are summarized by Tylor (Early History of Mankind, pp. 79–81), and he gives some credence to the one attributed to Akbar Khan, the great Mogul, since here the result of the isolation was that "they did not speak any language at all," a result quite in accord with probability. Some years ago the newspapers recorded a similar experiment, which had continued in Paris for several years, until discovered by the police, but the source of this information is highly suspicious (the daily press) and there was probably nothing in it.

It thus seems most probable that the beginnings and early development of human speech appeared among the half-human forms that lie between the present-day apes and the lowest types of modern men, and that the nascent accents of elemental language were uttered in association with the mammoth and cave bear during the Age of Ice. Even so, by a lucky chance, these early attempts have not perished without a trace, but have left faint records upon the fragments of bone that have come down to us, written in part upon chin and palate, and in part upon the cranial vaults that once covered that portion of the brain concerned with these activities.

It is many years since Broca, the French anthropologist, first showed that the *speech center* of the brain is unilateral, and located within the third frontal gyrus upon the left side; and now with the present more accurate knowledge of brain topography, the amount of development of this and other parts can be ascertained with some definiteness from an intercranial cast taken from the skull. In this way, limited by the existing fragments, such casts have been made of the brain of Pithecanthropus, the Neandertal and Gibraltar skulls, the much better preserved one from La Chapelle-aux-Saints, and most recently that from the skull of Eoanthropus.[1] In these casts the brain is seen as if lying beneath a veil of dura mater, and covered with its blood vessels, and the specimens have already yielded much to the specialists. Thus, aside from the general transition

[1] The following titles give the results of the study of the brain casts of the various transition forms discovered to date:—

DuBois, E. Remarks upon the brain cast of Pithecanthropus erectus. Proc. Fourth Internat. Congress Zoöl. Cambridge, 1898, p. 78.

Keith, A. On the Gibraltar skull and brain cast; report of paper delivered before the Royal Anthrop. Inst. Mar. 8, 1910, in Nature, March 17, 1910, and in L'Anthropol., XXI, 1910, p. 246.

Smith, G. Elliott. Appendix to the report on the Piltdown skull by Dawson and Woodward, in R. I. Geological Soc., March, 1913, pp. 107–151.

Boule and Anthony. L'Encephale de l'homme fossile de la Chapelle-aux-Saints. L'Anthropol., XXII, 1911, pp. 129–196. 26 Figs.

character of these brains, which is here expressed as plainly as in the bones, the form and degree of development of the speech center in each definitely marks the slow progress of human language. Already showing a beginning in *Pithecanthropus,* and still feeble in *Eoanthropus,* this speech center is more evident in *Homo neandertalensis,* although even here less manifest than in the recent species.

According to Boule and Anthony, who recently investigated the brain case of the skull from La Chapelle-aux-Saints, in the case of this specimen "we must believe, if not in the probable absence of articulate language, at least in the existence of only a rudimentary one."[1]

Quite another line of approach to the question of the origin of human speech is that furnished by the study of the most primitive languages now in existence, with some collateral evidence from the observation of children in their first attempts to speak. Here the natural sounds produced by such instinctive physiological processes as sighing, yawning, drawing in of the breath, blowing or spitting, all of them perfectly natural responses to stimuli of various sorts, are so closely related to certain word roots as to render it virtually certain that the latter have had their origin in the former. Another large class of roots seems as positively to have arisen from conscious imitation of the sounds of nature, such as the cries and calls of various animals, the sound of rushing water, of the wind, the rain, and so on. Still other root words of universal occurrence are due merely to the natural configuration of the organs used in articulate speech, the lips, tongue, and palate. When the child, or probably the paleolithic man, attempts to speak when his lips are closed they are forced open by the breath and the result is inevitably *pa* or *ma,* in accordance with the passage of his breath wholly through the mouth or through the mouth and nose combined, and continued attempts result in the natural repetitions of *papa* and *mama,*

[1] Boule and Anthony, loc. cit. p. 195 (free translation).

perhaps in human history, as in the nursery, the earliest words.[1]

It has been stated that the vocal sounds of monkeys are uttered with the intaken breath, and not with the outgoing, and if this be the case, and is found to persist in the "speech" of the higher apes, then the first *ma-ma* or the first sibilant s-s-s-s, produced by controlling the outgoing breath by the tip of the tongue, held back of the upper teeth, was the physiological, or perhaps only the mechanical, turning point which inaugurated human language. It is the province of the physical anthropologist to deal only with the beginning of such sounds as make up human speech, and this only in regard to the development of those anatomical proportions and peculiarities which render these sounds possible, for when these sounds are made, and furnished with a real meaning, no matter how general or indefinite, they become a language the investigation of which can be properly done only by the philologist.

Haeckel's hypothetical transition form was named by him *Pithecanthropus alalus*, or the *speechless*, but DuBois' fossil from Java possessed not only a tongue and palate (as deduced from the proportions of the teeth) capable of producing certain of the elemental sounds of human language, but showed also some slight development of the speech center of Broca, and on this account the discoverer replaced the specific name of *alalus* with that of *erectus*, thus substituting for a characteristic of doubtful appropriateness one of which he was certain, the fact that it stood upright like a man.

67. Summary: The Phylogenetic Tree of the Primates; the Pedigree of the Human Race. After the consideration of the living Primates, together with all the

[1] For an excellent short account of the early development of language cf. Tylor, Primitive Culture, I, Chaps. V and VI, also Early History of Mankind, by the same author, Chap. IV.

available information concerning the Primates of past ages; after the comparison of such important structural details in each as the teeth, the proportions of the cranium, the structure of the brain, and the form of the hands and feet, we are now ready to employ these facts in an attempt to arrange these numerous animals in accordance with their course of development; placing them in such a relation to one another that their various characteristics may be shown in an orderly series, representing the development as nearly as possible as it took place in reality.

Naturally there have been many attempts at making such a phylogenetic arrangement of the various Primate forms, and the diagram expressing this must vary with each attempt, in accordance with the system which for the time being seems of especial importance, or to which the attention of the author has been especially directed. As each attempt thus embodies certain truths it is well worth while to consider certain of the most authoritative ones, especially those based upon the more recent discoveries in the paleontological field.

The first phylogenetic tree here presented is that of DuBois (1896)[1] constructed soon after his discovery and subsequent study of the Javan link form, *Pithecanthropus*, and based upon a previous diagram of Haeckel.[2] The development starts with an hypothetical form of Eocene date, *Archipithecus*. This form is purely hypothetical, and is not suggested by any of the known Eocene Primates, like *Pelycodus*, *Notharctus*, or *Tetonius*, since these latter are lemuroid, but is rather the generalized ancestor of the non-lemurine Primates, distinguished in this book as the Sub-Order Anthropoidea. Although not as yet substantiated by actual fossil remains, this form, *Archipithecus*, assumes the

[1] DuBois, E. Pithecanthropus erectus, eine Stammform des Menschen. Anat. Anz., Bd. XII, 1896, p. 21.

[2] Haeckel, E. Systematische Phylogenie der Wirbeltiere. Berlin, 1895, p. 601.

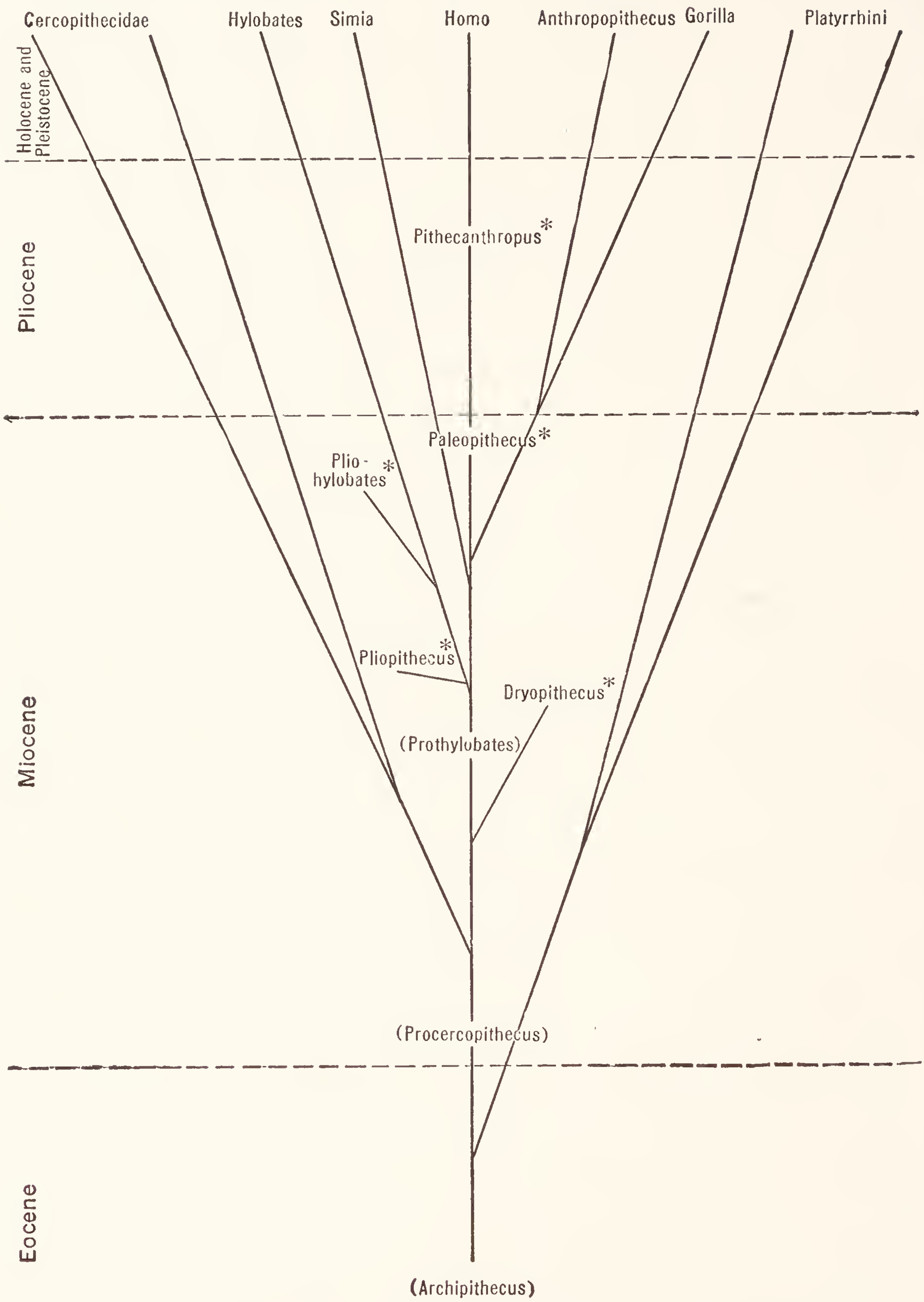


FIG. 88. Phylogenetic tree of the Anthropoidea, based upon the general anatomical structure, and arranged to correspond with the Geological chronology. Hypothetical forms are enclosed in brackets; extinct forms are starred. *Pliohylobates* is based upon the femur from Eppelsheim; *Pliopithecus* comes from Sansan, in the south of France, and *Paleopithecus* from the Sivalik Hills in India. Dr. DuBois studied the remains of this latter in the Museum of Calcutta, and thinks it the immediate ancestor of Pithecanthropus. After DuBois.

contemporaneous existence, in the Eocene, of both lemuroid and anthropoid forms, already differentiated, and that the generalized ancestral forms of the two modern Sub-Orders existed then side by side.

From this common ancestral anthropoid the branch leading to the American forms, the Platyrrhini, was the first to depart, still in the Eocene, and is here represented by the branch upon the extreme right. This leaves the katarrhine group represented by its generalized, hypothetical, ancestor, *Procercopithecus,* to which we must assign a dental formula with two premolars and three molars, an ossified tube reinforcing the acustic meatus, and the other characters possessed in common by the modern Lasiopygidae and the higher apes. In the early Miocene the true Lasiopygidae departed from the main stock (the branch on the left), leaving only the forms included here under the Simiidae. Of this group the oldest known representative is *Dryopithecus,* from the European oak forests of the Mid-Miocene, and its position not precisely in but near the human line is shown by the short side branch leading to it. The actual ancestor was nearer the recent forms, and is here represented by the hypothetical *Prothylobates,* from which there branched (to the left in the diagram) the modern Genus *Hylobates,* along the line of development indicated by the actual fossils, *Pliopithecus* and *Pliohylobates,* both Miocene in spite of their names.

The modern Genera *Simia* (*Pongo*), *Anthropopithecus* (*Pan*), and *Gorilla* began their differentiation a little later, after the complete separation of *Hylobates; Simia* (*Pongo*) by itself and a little earlier, and the two others together, with a difference between them appearing still later. This left but one line, represented here as the main one, during the development of which the modern human type was gradually assumed through the known forms *Paleopithecus* and *Pithecanthropus,* the one from the Sivalik Hills of India, the other from the island of Java, both tropical Asiatic.

The next diagram presented, that of Schlaginhaufen

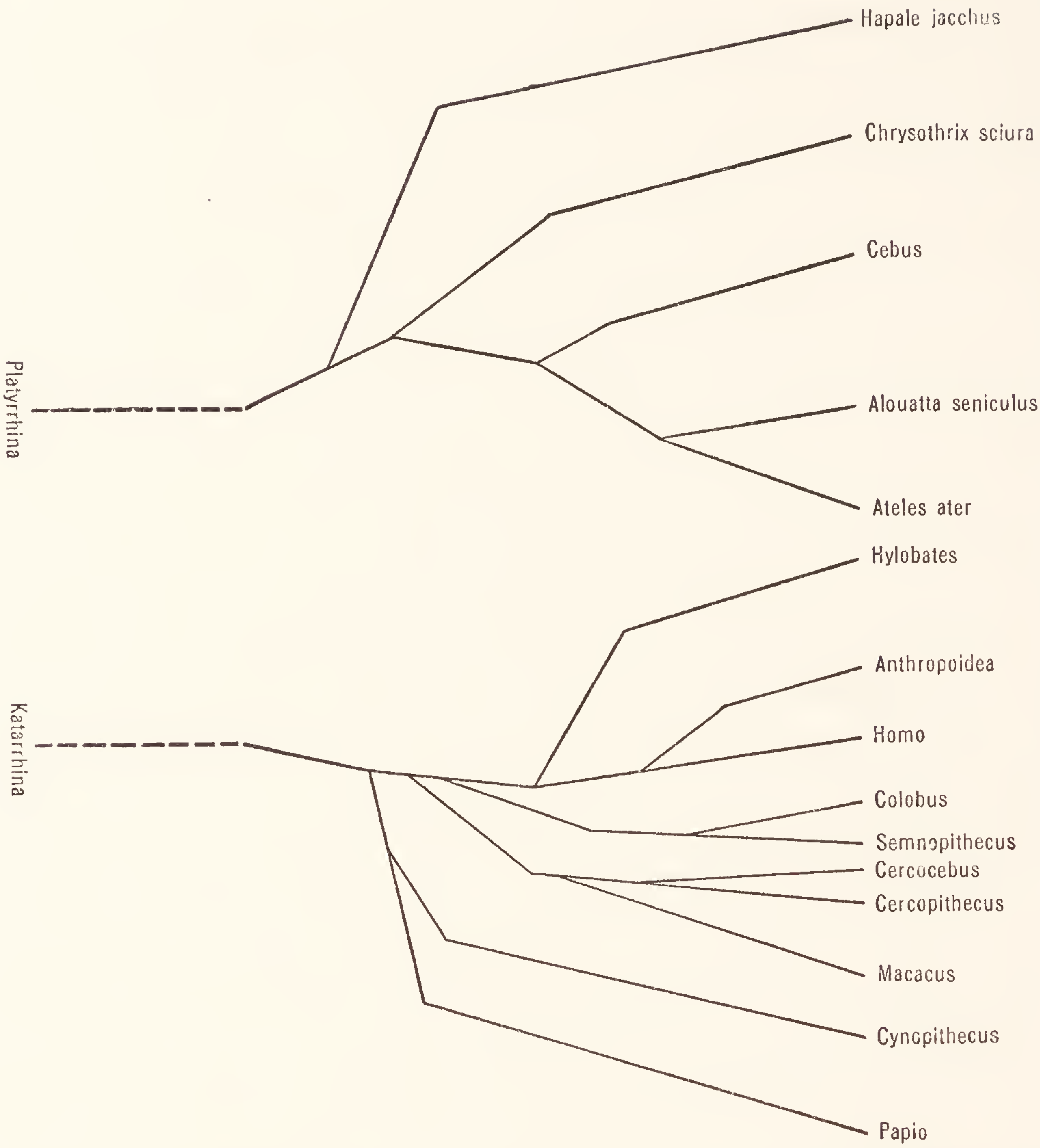


Fig. 89. Phylogenetic tree of the Anthropoidea as based upon the epidermic patterns of the soles. The Platyrrhine and Katarrhine groups are treated as distinct, yet with the suggestion of early relationship suggested by the inclination of the lines at the base of the two. The word "Anthropoidea" is used here in the sense of the Simians. After Schlaginhaufen.

(1905), is rather a grouping of the living "Anthropoidea" (Hominidae) into their relationships with each other than a general phylogenetic tree of the Primates; but is of especial interest here, since it is derived from the study of the epidermic markings on the sole, a rather unusual anatomical point to use for taxonomic purposes.[1] The two groups of the

[1] Schlaginhaufen, O.; Das Hautleistensystem der Primatenplanta, unter Mitberücksichtigung der Palma. Morph. Jahrb., Bd. XXXIII, 1905, p. 119.

Old and New World forms, Platyrrhini and Katarrhini, are placed here as two distinct groups, but their derivation from a common source in the distant past is indicated by the convergence of their main stems at the bottom of the diagram. The most important points for our purpose are shown in (1) the early and more complete separation of Hylobates from the Simian stem, a conclusion exactly in accord with the data furnished by other anatomical studies, and (2) the close relation of Man to the chimpanzee, *Pan*. Unfortunately, as the author did not obtain for study any gorilla or orang-utan material, these important forms are lacking. It is also of general interest, although for us a little remote, that the baboons, *Cynopithecus* and *Papio*, which in their general structure depart the most widely from the typical Cercopithecidae (Lasiopygidae), are shown in the same distant relationship by the testimony of the plantar markings.

The last phylogenetic tree here given, prepared especially to illustrate this work, differs from the others more in scope than in ideas, and makes the attempt to include all Primate forms, both living and extinct, and to relate them to the more generalized mammals from which they arose. *Pelycodus* here figures as the oldest and most generalized Primate, or mammal with Primate tendencies, and this is plainly related to the Eocene Insectivora, like *Hyopsodus*, probably the ancestor of the modern Order of this name. *Pelycodus* may have given rise to two lines of development, one of which was a very special one, which reduced the number of incisors, something after the manner of the rodents, without being closely related to them, and developed along the line marked by *Microsyops* and *Mixodectes* into the aye-aye of Madagascar, *Daubentonia* (*Chiromys*). The other began with *Notharctus*, and probably *Adapis*, from which the group of the modern lemurs took its origin, and from which also through a lost form, *a*, the higher lines of Anthropoidea were to be derived. This form was a small,

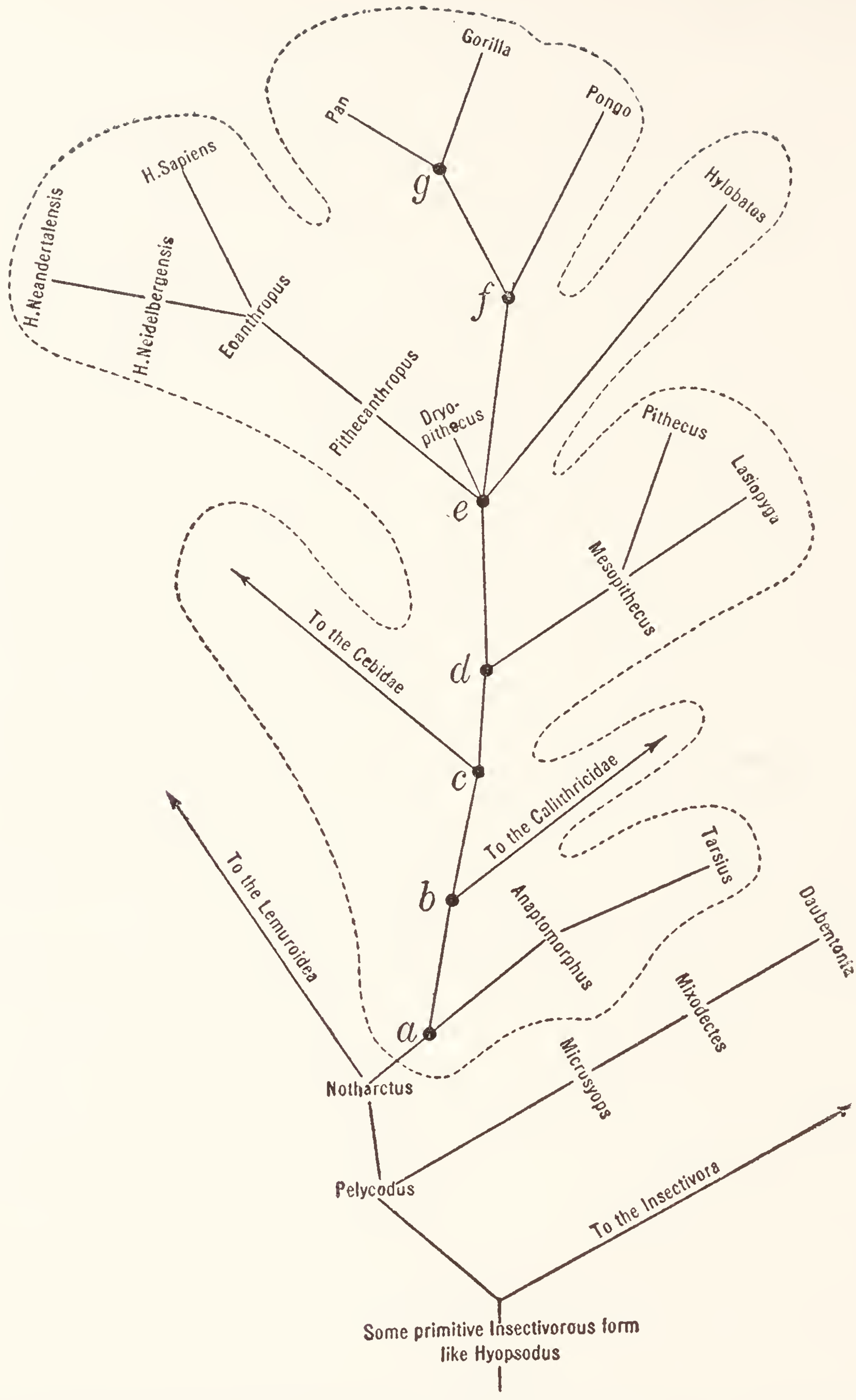


FIG. 90. Phylogenetic tree of the Primates, expressing the ideas of the present author, and largely based upon hypothetical forms.

a. The primordial Anthropoid, much like *Notharctus*, but developed along the line of which *Tetonius* is a more extreme specialization.

b. The point of differentiation of the Callithricidae. The location of this ancestor is highly conjectural. It may have been the *Archipithecus* of DuBois.

c. The last common ancestor of the Cebidae and the Cercopithecidae (Lasiopygidae). Its digits were all furnished with nails and its dental formula was like that of the Cebidae, with three premolars and three molars on each side of each jaw.

d. The primordial Lasiopygid, *Procercopithecus*, much like *c* but with two premolars.

e. The primordial Simian Ape. Here branches the line leading up to the gibbons, *Hylobatinae;* also probably to the *Homininae*.

f. The last common ancestor of the three living anthropoid apes, after taking out the gibbons. Here branch off two lines, the one leading to the Genus *Simia* (= *Pongo*), the other to the hypothetical form *g*, the direct ancestor of the chimpanzee and the gorilla.

The living Anthropoidea are shown as the final lobes of this tree which indicate the modern fauna.

nocturnal creature, which had large eyes, and developed for their support bony orbital walls at the expense of the nose, the cavities of which became reduced. The face also, owing to the increased activity of the prehensile hands, and the reduction of the teeth, became flattened, as described above. Still further specialization along these lines thus laid out developed in the direction of *Tetonius* and *Tarsius*, while the more generalized line continued to form *b*, also theoretical. This form somewhat resembled the Callithricidae of modern times, to which it gave rise, but its still generalized descendant, hypothetical form *c*, still with three premolars, gave direct origin to the Cebidae. Form *d* is the first with two premolars, and seems very much like the "*Procercopithecus*" of Haeckel and DuBois, as it is a generalized cercopithecid (lasiopygid), from which the latter Family is derived; and form *e* is already simian, tailless, with reduced ischial callosities, and probably with a flat mesosternum in one piece.

Hypothetical form *e* may have been actually represented by *Dryopithecus*, or at least this Miocene European ape must have closely resembled it. Its near kinship to *e* is here expressed by the shortness of the line connecting the two.

At this point it is possible that three different lines of development were taken, as here indicated, but the records are quite incomplete. It may be generally conceded, however, that at about this point the gibbons, Sub-Family Hylobatinae, separated here from the other hominids, and that consequently form *e*, and undoubtedly *Dryopithecus* also, still retained the small ischial callosities and a few other lasiopygid features. These were soon dropped by the main simian line, which, through the forms *f* and *g*, developed into the modern apes of the Genera *Pongo*, *Pan*, and *Gorilla*, the two last nearer each other than is the first to either.

No one would be willing to say, at the present state of our knowledge, just where the line leading to the Homininae

departed from the main stem, but if we include *Pithecanthropus,* as seems probable, it was at least as early as the point designated by form *e,* and possibly a little earlier. The two features especially emphasized by this line of development were the maintenance of an erect position, and the rapid increase in the size and development of a brain and an articulate language, while for a considerable time the jaws remained heavy and ape-like, and the skull was thick and brutal. Within the last thirty years have come the successive discoveries of *Pithecanthropus, Homo heidelbergensis,* and *Eoanthropus,* together with a greatly increased knowledge of the details of *Homo neandertalensis,* and while each has shed much light upon man's immediate pedigree, yet each form found has presented in itself a new problem in establishing its own position relative to the others. Thus but little reliance can be placed upon any phylogenetic diagram of these forms, but the one here given will express in a general way that *Pithecanthropus* belongs at the bottom of the human series, that *Eoanthropus* stands, in regard to its jaw, intermediate between it and *Homo heidelbergensis,* but that the cranium of *Eoanthropus* comes nearer the present species of man in some respects than any of the other extinct forms. It is because of this last fact that modern man is here represented as the direct descendant of *Eoanthropus,* while *Homo neandertalensis* is placed on a collateral line, and the hypothesis thus expressed reflects an opinion largely felt at the present time. In this connection the newly discovered skull of *Australopithecus,* recently found in Bechuanaland, South Africa, is of the greatest importance. Broom places it in the main line leading to man, a little lower than *Pithecanthropus,* which, in its turn, leads directly to *Eoanthropus,* while the living apes, *Pan, Pongo,* and *Gorilla,* as well as the two other species of *Homo,* are put along side branches, that is, not directly ancestral to modern Man.

CHAPTER V.

ETHNOLOGY; RACIAL CHARACTERISTICS

68. What People Are Asking Concerning Human Races. This subject is both introduced and defined by quoting the following extract from an unknown source, probably some well-meaning sort of propaganda, which I find in my notes, having undoubtedly floated in through the mail. It gives exactly the questions that people are now asking, the subjects that they are particularly interested in, and for which they are seeking answers in anthropology. This is the quotation.

"What is a 'race'? Did the human 'race' spring from a single origin, or from many origins? What are the latest pronouncements of science on this question? How many 'races' exist in the world today? Have any 'races' disappeared in the course of history? If the human 'race' came from many origins, what was the number of those origins? If the human race came from a single origin, how have the varied 'races' we know today been derived? If these various races came from a single origin, does that mean that Whites and Negroes both came from the same ancestor? That members of the Ku Klux Klan and Jews, Catholics and Negroes all came from a single remote ancestor? If these various 'races' did not all come from a single 'race,' how many original 'races' have there been? How many of these original 'races' still exist today? Do all the various representatives of a single existent 'race' love one another? If not, how can their attitudes be explained? If they hate one another, do they show more, or less, hate in this relationship than they each show toward some other 'race' lying outside the bounds of their own descent? That is to say, is there any formula for racial hatred, or for racial respect, that is of universal application? Is there any formula for racial inferiorities and superiorities that holds without exception? Has any one, at the present time, a convincing, workable program for the guidance of our immigration

officials or congress in the matter of admission? Under these circumstances is intolerance the most admirable and reasonable of attitudes?"

A generation ago we in North America were forced to consider an important racial question, as a direct result of the Civil War. This war, and this vital racial question, were brought about by the unfortunate policy of having introduced a few people of an alien race to work at forced labor for their more fortunate masters, then temporarily in a position of absolute control. Except for a handful of aborigines, the dominant people were pretty homogeneous in descent, and the problem of races, as seen by them at that time involved simply two kinds of people, the "blacks" and the "whites," and we got to speaking of "the color line" as if the whole matter was simply a question of two entirely distinct peoples, as distinct as two zoölogically distinct species. If, at that time, we had had the experience of even different immigrant European nations as we have now; if we had then had the experience of the blend of different languages, customs, and religions which we have at the present time, we would have been more tolerant, and the problem would not have seemed so simple. Certain places in the world, those where the great trade-routes cross one another, have been from very early times like great railway stations, genuine metropoles where the mixture of many kinds of humanity has long turned them into museums of ethnology, compared to which the questions that confronted our ancestors with their "color line" appears surprisingly simple. Alfred Russell Wallace described Singapore, as he found it in 1854, as follows:—

"Few places are more interesting to a traveller from Europe than the town and island of Singapore, furnishing, as it does, examples of a variety of Eastern races, and of many different religions and modes of life. The government, the garrison, the chief merchants, are English; but the great mass of the population is Chinese . . . The native Malays are usually

fishermen and boatmen, and they form the main body of the police. The Portuguese of Malacca supply a large number of the clerks and smaller merchants. The Klings of Western India are a numerous body of Mahometans, and, with many Arabs, are petty merchants and shopkeepers. The grooms and washermen are all Bengalees, and there is a small but highly respectable class of Parsee merchants. Besides these, there are numbers of Javanese sailors and domestic servants, as well as traders from Celebes, Bali, and many other islands of the [Malay] archipelago. The harbour is crowded with men-of-war and trading vessels of many European nations, and hundreds of Malay praus and Chinese junks, from vessels of several hundred tons burthen down to little fishing boats and passenger sampans; and the town comprises handsome public buildings and churches, Mahometan mosques, Hindoo temples, Chinese joss-houses, good European houses, massive warehouses, queer old Kling and Chinese bazaars, and long suburbs of Chinese and Malay cottages." (Wallace; Malay Archipelago, Chapter II.)

A quite similar description of Cairo was given by the Earl of Cromer in 1908. He imagines himself in the streets of the capital city of modern Egypt, and gives the following colorful picture of his constant experience:—

"If any one walks down one of the principal streets of London, Paris, or Berlin, nine out of ten of the people with whom he meets bear on their faces evidence, more or less palpable, that they are Englishmen, Frenchmen, or Germans. But let any one who has a general acquaintance with the appearance and physiognomy of the principal Eastern races try if he can give a fair ethnological description of the first ten people he meets in one of the streets of Cairo. . . . He will find it no easy matter, and with all his experience he may not improbably make many mistakes.

"The first passer-by is manifestly an Egyptian fellah who has come into the city to sell his garden produce. The headgear, dress, and aquiline nose of the second render it

easy to recognize a Bedouin, who is perhaps come to Cairo to buy ammunition for his flint-lock gun, but who is ill at ease amidst urban surroundings, and will hasten to return to the more congenial air of the desert. The small, thick-lipped man with dreamy eyes, who has a far-away look of one of the bas-reliefs on an ancient Egyptian tomb, but who Champollion and other savants tell us is not the lineal descendant of the ancient Egyptians, is presumably a Coptic clerk in some government office. The face which peers somewhat loweringly over a heavy moustache from the window of a passing brougham, is probably that of some Turko-Egyptian pascha. The man with the bold, handsome, cruel, face who swaggers by in long boots, and baggy trousers, must surely be a Circassian. The Syrian money-lender, who comes next, will get out of his way, albeit he may be about to sell up the Circassian's property the next day to recover a loan of which the capital and interest, at any ordinary rate, have been already paid twenty times over. The green turban, dignified mien, and slow gait of the seventh passer-by denote some pious Sheikh, perhaps on his way to the famous University of El Azhar. The eighth must be a Jew, who has just returned from a tour in Asia Minor with a stock of embroideries, which he is about to sell to the winter tourists. The ninth would seem to be some Levantine non-descript, whose ethnological status defies diagnosis, and the tenth, though not easily distinguishable from the latter class, is in reality one of the petty traders of whom Greece is so prolific, and who are to be found dotted all over the Ottoman dominions. Nor is the list yet exhausted. Armenians, Tunisians, Algerians, Soudanese, Maltese, half-breeds of every description, and pure-blooded Europeans pass by in procession, and all go to swell the mass, if not of Egyptians, at all events of dwellers in Egypt." (The Earl of Cromer; Modern Egypt, Macmillan, 1908, Vol. I, pp. 127-128.)

Surely, compared with either of the above descriptions, the much-talked-about "melting-pot" now found in the

United States, even on the East Side of New York, seems quite an ordinary gathering.

69. Varieties, Sub-species and "Races" among Animals. In all animals whose success in life is so considerable that they become in great part protected from their natural enemies and the menace of starvation, the tendency to vary becomes so potent that numerous well-marked varieties appear, the more constant and definite of which are termed *Sub-species* or *Races*. This tendency is especially shown by all domestic animals, and is in direct proportion to the amount of attention they have received, as may be seen by comparing dogs with goats, or pigeons with swans. The biological causes of this greater amount of variation in successful species are numerous and the problem is a complex one; but two of the main causes are the partial suspension of the conservative influence of Natural Selection, and a definite, usually intentional, plan regulating the mating of individuals.

In the case of certain animals, as the pigeon, for example, the domestication has been very recent, and the history of the entire process is fairly well known; in other animals, however, like the dog, the domestication is well-nigh as old as is the human race, and the early history of the first domestication of the original stock is lost in the obscurity of the distant past. In such a case as the last we may restore a part of the history by the help of a careful examination of the various races or breeds themselves, including the excavated remains of prehistoric forms, but much of it can never be known. In most domestic animals it is likely that all the modern breeds have descended from a single ancestral species (*monophyletic*), but in a few instances, notably that of the dog, there is some basis for the supposition that the matter is considerably more complex; that there were several specifically distinct ancestors, independently domesticated by primitive men in different parts of the world; and that the descendants, being nearly related, have since blended

(*polyphyletic*). The subsequent extinction of the original wild ancestors has naturally destroyed the essential part of the early records.

As an extremely successful species Man is by no means exempt from this general biological law of variation, and the numerous human varieties, which exhibit all degrees of distinctness from one another up to, but not yet surpassing in living men, the bounds of a zoölogical species, are the result. These, when sufficiently distinct, are spoken of as *races*, rather than *varieties*, and here also, as in other cases, numerous problems present themselves concerning their proper subdivison and interrelations. To begin with, nearly all authorities agree that all the races now living constitute only the varieties of a single zoölogical species which had but a single origin, and that in some rather restricted geographical locality. Concerning the varieties themselves, however, and the place and relative period of time at which the gradual differentiation has taken place, there is much less agreement and there is a general feeling that at present the data are far too scanty to render any definite formulation possible.

70. Ethnology and its Related Branches. These problems, the determination of the primary human races, their fundamental physical characteristics, their origin and subsequent migrations, constitute that branch of anthropology designated *ethnology*, or the study of races. Another convenient term, not a synonym for the former, but rather to be considered a distinct though closely associated branch, is that of *ethnography*, literally the *description of races*, which deals with them in their natural environment and occupies itself with the details of their houses, utensils, and clothing; their language, literature, and art; their ethics and philosophy. In contrast to this the term ethnology is frequently used in the restricted sense of the *physical anthropology* of races, that is, the study of human varieties from the zoölogical standpoint; the determination of the different varieties

or sub-species, and their interrelations. The study of the physical characters alone constitutes in itself an important subdivision, which may be designated as *somatology,* the study of the body, or as *anthropography,* the *description of man;* and, lastly, as many of these rest upon series of accurate measurements, both of the living body and of the bones, there is also need of the convenient term *anthropometry,* to include the study of such characters apart from others.

71. What is a Race? The word "*race*" is popularly so carelessly used, and in so indefinite a manner, referring now to one of the fundamental divisions of humanity and now to the people of a given locality, united merely by geographical, linguistic, or political affinities, that it is the first duty of the ethnologist to see if there be in reality any such thing as a "race," and if the word be capable of an accurate scientific definition. It is true that certain grand divisions of the human species, as the Mongolians, the Negroes, or the Europeans, seem to have a scientific basis for their separation, but we commonly speak in much the same way of the "Jewish race," the "Anglo-Saxon race," and the "Latin race," etc., although these latter divisions are, to say the least, subordinate ones, often based upon a common language or political interest rather than a close blood relationship. Political prejudice especially is a frequent cause of error, and often leads men to believe that the people included within certain artificial boundaries form an ethnological unit, "of one blood" as the saying is, or "blood is thicker than water," and that often in face of the fact that the boundaries used have not remained the same even within the short period known to history. The ethnologist knows that in certain countries of Europe, in which this form of patriotism runs the highest, and where the unity of origin is constantly emphasized by the political leaders, the inhabitants comprise several distinct ethnic types, with such fundamental physical characters as the shape and proportions of the head, quite at

variance with each other. This is by no means a wilful deception on the part of the political leaders, for in the main they are seeking the same goal as the ethnologist, that is, the grouping of the people into political units in accordance with racial affinities, but to one untrained in zoölogical methods, such superficial characters as language, dress, customs, and preferences are relied upon as criteria, while the characters studied by the ethnologist are those of the bodily features, both in the living and dead body and in the skeleton. Ignoring all political, traditional, and emotional prejudices, it is his duty to examine men by the measuring tape, the calipers and the scalpel; to devote even more attention to the bones than to the living bodies; and from the data thus furnished to establish the distinctive human types, to determine their present geographical boundaries, and to trace the prehistoric migrations which have brought them into their present condition.

To such a student the term "*race*" becomes a synonym for *a well-marked human variety*, the members of which possess certain essential physical traits in common, traits which, either singly or perhaps in certain combinations, are unlike those possessed by other varieties. The term cannot, however, be a very exact one, for, by the nature of the case, all such varieties are interrelated, and become isolated only by the disappearance of the transition forms. Again, these groups are of very unequal value as to size and relation to each other; as some of them form the larger varieties, or sub-species, of the human race, including, perhaps, the inhabitants of an entire continent, while others are smaller subdivisions, subordinated in point of rank to the former. Thus a race cannot be exactly defined, but the term will be used throughout this book in the sense of physical similarity, independent of all political or linguistic affiliations.

72. Pure vs. Mixed Races. It is the constant endeavor of the animal breeder to keep his valuable breeds, or varieties, "pure," that is, unmixed with other blood; an endeavor

which leads to precautions that are often more or less needless, but which ensure the constant throwing out of individuals upon the slightest suspicion of taint. In this way a breed, once obtained and proven valuable, may be retained and propagated through a large number of generations without perceptible change; every individual having the desired qualities to about the same degree. In such a carefully bred stock the separate individuals come to look very much alike, and thus as it becomes easy to distinguish a member of this breed from others, so it becomes increasingly difficult to distinguish from one another the individuals that compose it.

In the case of Man, who, as an animal, is similarly susceptible to the effect of breeding, although there has never yet been any conscious endeavor to produce special races, yet numerous circumstances have from early times been continually operative to produce just such results. There is, first, race prejudice always present, the natural antipathy to "foreigners," or "barbarians," people who look and speak in a different way; and in primitive society, where there are very ineffectual means of transportation, people living a few miles distant are looked upon as such. A more effective cause is to be found in geographical isolation, such as may occur on an island, or through the interposition of high mountain ranges, impassable rivers, or seas; and such isolated areas have undoubtedly been, in the remote past, the cradles of certain of the most distinct human varieties. When, however, through the invention of boats, the construction of bridges, the introduction of draught animals, and other means, the natural barriers become less effectual and the intervening distances practically lessened, two important results accrue; certain successful pure races burst the bounds of their original territory and spread over a more extensive area, as, for example, the Negroes in Central Africa or the American Indian over the Western world (although neither of these peoples were respectively African or American in ultimate origin); and, secondly, there would

be extensive fusion of races along the contiguous borders. In places where a number of small but distinct races have been overwhelmed by the inundation of a very successful one the ultimate confusion might become very great, and there would remain within the territory appropriated by this latter stock many little peoples of originally independent origin, ethnic nuclei that did not happen to develop, but who are of equal importance with the successful ones from the standpoint of the scientific ethnologist.

Such people very often become mixed in blood with the dominant race, adopt their manners and customs, their dress and language, and eventually so merge with their conquerors that they serve merely to augment the population, "lost to name and fame" save to the ethnologist; in other cases, however, the social or ethical gulf between them is too great and, although taking on certain of the marks of external culture, prejudice keeps them racially distinct. Thus, even in such a case as an enclave of primitive people within the limits of a civilized nation, like the Lapps in Sweden, the two remain as isolated physically as though separated by impassable geographical barriers. The Ainus in Japan may have but little Japanese blood, the Igorotes in Luzon remain isolated from the Malays, and the Veddahs still roam through the forests of Southern Ceylon unmixed with the numerous ethnic strains represented by the cultured peoples surrounding them. (See Frontispiece)

Still, even with the isolation of prejudice, the separation of such races is none too secure, and the inevitable civilizing process, with the school system and the work of the missionaries, will break down these barriers and cause the blood to become mixed. It is thus of the greatest importance that all such tribes be studied while there is yet time; and studied, too, not by the superficial traveler who journeys through their country, taking a few photographs, and making a few measurements, but by one who is willing to live with them long enough to gain their full confidence and sympathy,

learn their language, their philosophy and ethics, their folk-lore and religious worship. Such men, and, fortunately, there have been and are many such, who in the early twentieth century may still carry out such studies among peoples like the Dyaks, the Igorotes, the Amdamanese, the Seri, will become classical authorities, collectors of knowledge lost to the world save for them. Their work will prove to be of more importance than the records of Tacitus and Julius Caesar concerning the tribes of Britain, France, and Germany, for it will be the last opportunity the world will afford to study primitive peoples, untouched by extraneous influence.

Even these last refuges of unmixed stock will soon be infested everywhere by civilized invaders, while the ethnological complexity developing along the main routes of travel and the centers of commerce is already too extreme to render analysis of race longer possible.

Probably the most striking difference to people in general is the color of the skin, a degree of pigmentation more than a slight amount being looked upon as a mark of mental or moral inferiority. As a matter of fact there is scarcely a character upon which so little real significance can be placed, or so little of real affinity can be determined. Pigmentation is a matter of adaptation to a certain climate, and always develops in response to the degree of sunlight. Whether this is direct (Lamarckian) or indirect (Darwinian) must be still left to the biologists, yet there can be no doubt that it is a definite adaptation. The African Negro or the Hindu are, both of them, far better adapted to their original home than are the pale white men from a more northern clime who try to settle there.

Aside from the color of the skin other racial differences almost equally striking are found in certain facial features like the slanting eyes of the Chinese or the broad and high cheek-bones of the American Indians. Hair is also quite characteristic, and we naturally think at once of the straight black hair of these same two races, and the thick, matted

wool of the Negro. In fact hair is one of the best racial criteria, and certainly better than that highly changeable character, the color of the skin. The nose and the mouth with its lips are also important, as we acknowledge instinctively in connection with the Jews and the Negroes. There is no better introduction to the study of Ethnology than to pass in review the series of the more important features, mainly those of the face, to ascertain the points that occur, and the differences that are found in different parts of the world.

We may take these up in the following order, which will include the most obvious ones:—

Human Characters of Racial Value.

Shape of head
Shape of face
Eyes
Nose
Mouth and lips
Degree of prognathism
Hair
Skin color
Bodily proportions
Special physical characters of racial significance

73. Head Shapes: Cranial Index. A far more deep-seated and fundamental physical character than skin-color is the shape of the head when viewed from above, or that of the periphery as marked by the hat.

There are two distinct methods by which anthropologists have sought to estimate and record this character; the one by means of accurate measurements, the other by the comparison of shapes. The first of these, the *anthropometric*, is much the older one, and has now been in extensive use for more than a half century; the second, or *morphological* method, is recent in its application, and has not as yet been widely used, or even generally accepted as a legitimate method.

The anthropometric method of dealing with cranial

shapes consists essentially of obtaining an accurate measurement of the maximum length of the head, in the median line, from forehead to occiput, and comparing this with the greatest breadth, taken at right angles to the first. The comparison is made by the calculation of an index in the usual way, the index expressing the value of the breadth in terms of the length. That is, the proportion is expressed thus:

$$\text{Length} : \text{breadth} :: 100 : x$$

or, in the usual form,

$$x = \frac{\text{breadth} \times 100}{\text{length}}$$

The measurements are taken by means of specially devised calipers, the craniometer, of which there are several forms. The one most in use is essentially like an ordinary pair of measuring calipers as used by carpenters, save that the legs, near their free end, are so curved that the tips point inwards. The distance between these points, which are made blunt and slightly rounded in order that they may be conveniently applied to the surface of the living head, is indicated by a graduated scale borne on a metallic arc. This scale, which is naturally a reduced one, as it is to indicate the measurement of the arc of a larger circle, is fastened to one leg and allows the other to slip past it. A line, marked on the movable leg, indicates precisely the measurement to be recorded. To prevent any error due to slipping of the parts after a measurement is taken the movable leg may be temporarily fastened to the measuring arc by means of a binding screw while the measurement is being taken, after which the instrument may be handled without fear of displacement.

For the length measurement the glabella-inion line was formerly used, but as a matter of fact the inion which, to define it anatomically, is that point on the external surface that corresponds to the middle point of the internal occipital protuberance, is not always, and even rarely, the terminus

of the maximum length line. In practice, therefore, one leg of the craniometer is held upon the glabella, while the other is run back and forth over the back of the skull, keeping it accurately in the median line, until the graduated arc indicates that the points of the legs are at their greatest possible distance. The instrument is then clamped and removed from the skull, but is best tested by a second application immediately after.

The breadth is taken in much the same way, the calipers being held transversely across the skull, and the points

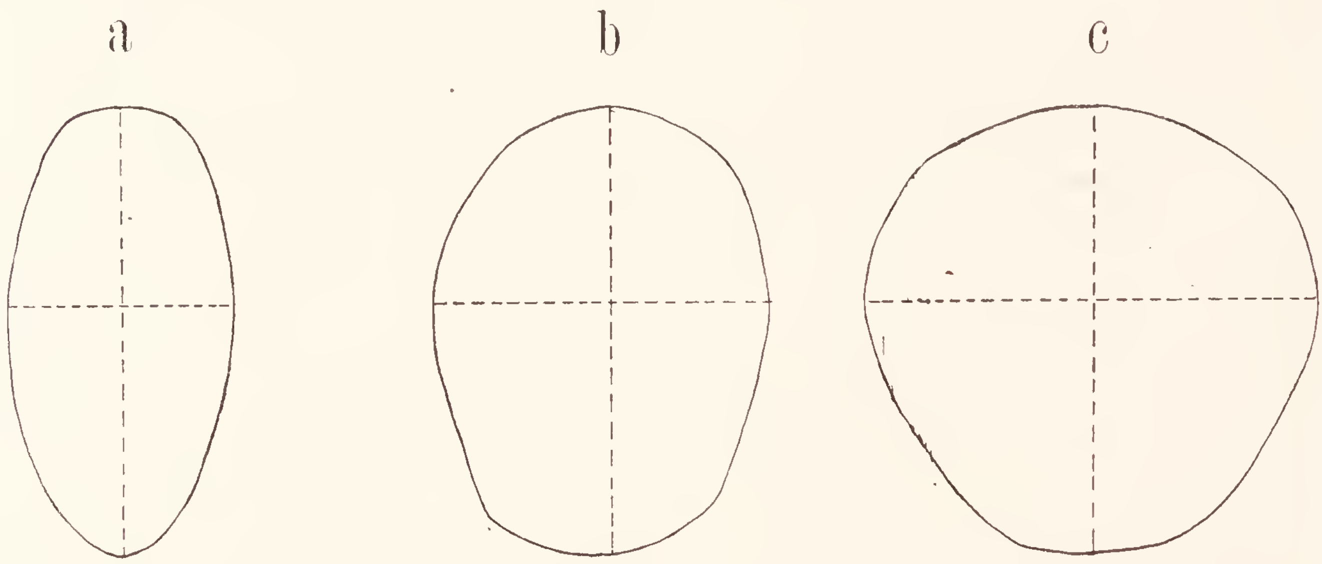


FIG. 91. Diagram illustrating the Cranial Index. This is in all cases the length of the maximum breadth line, expressed in terms of the maximum length, that is, in the form of a decimal. In *a* this line is one-half the length, in *b* it is three-fourths, and in *c* it is equal to it; the three indices are thus 50, 75, and 100 respectively. Actual human heads are never, in normal cases, so narrow as *a* nor so broad as *c*, ranging between about the limits of 55 and 96.

caused to slide over the surface until the graduated arc indicates the maximum distance. Each of the two lateral points upon which the legs of the calipers finally rest is termed by von Török the "euryon," a point which, like the previous one, is determined, not anatomically, but in relation to a definite proportion. These points are usually found to be above the auditory region, either upon the squamosal or the parietal, and should be approximately opposite each other, at least in a symmetrical skull.

The resulting index gives the exact proportion between breadth and length and thus indicates whether the head be narrow (long) or broad (short), the former being indicated by the smaller numbers. Thus, if the breadth is but half the length, i. e., half 100, the index would be 50; if three-quarters, 75; if equal to it, 100. As a matter of fact, no normal human head has quite as small an index as 50, or quite so large a one as 100, but one-half of the human race falls somewhere between 75 and 80, or *mesocephalic.* Heads with an index of less than 75 are called long or *dolichocephalic,* and heads with an index above 80 are *brachycephalic.* This

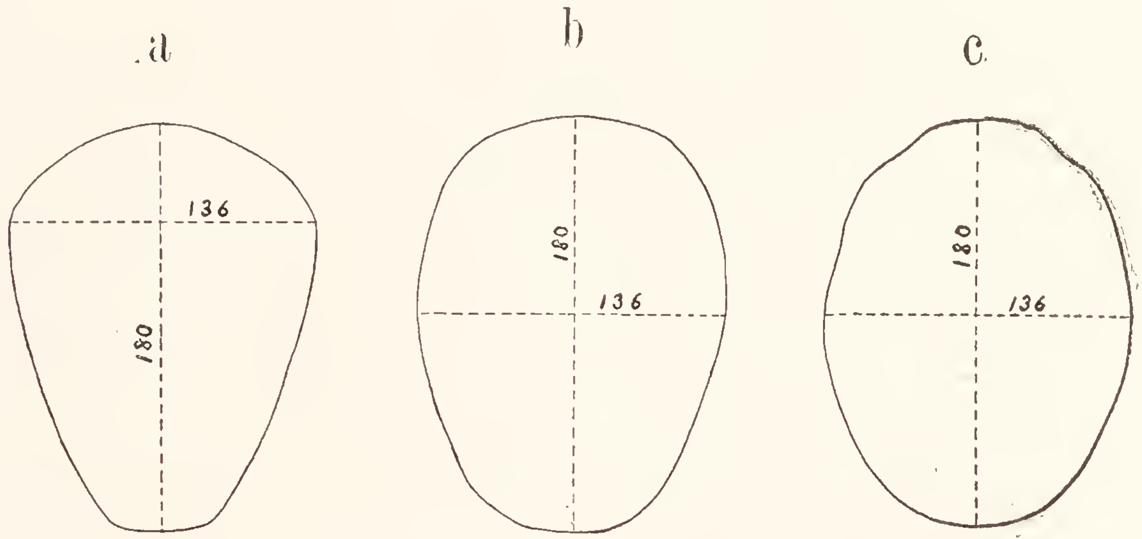
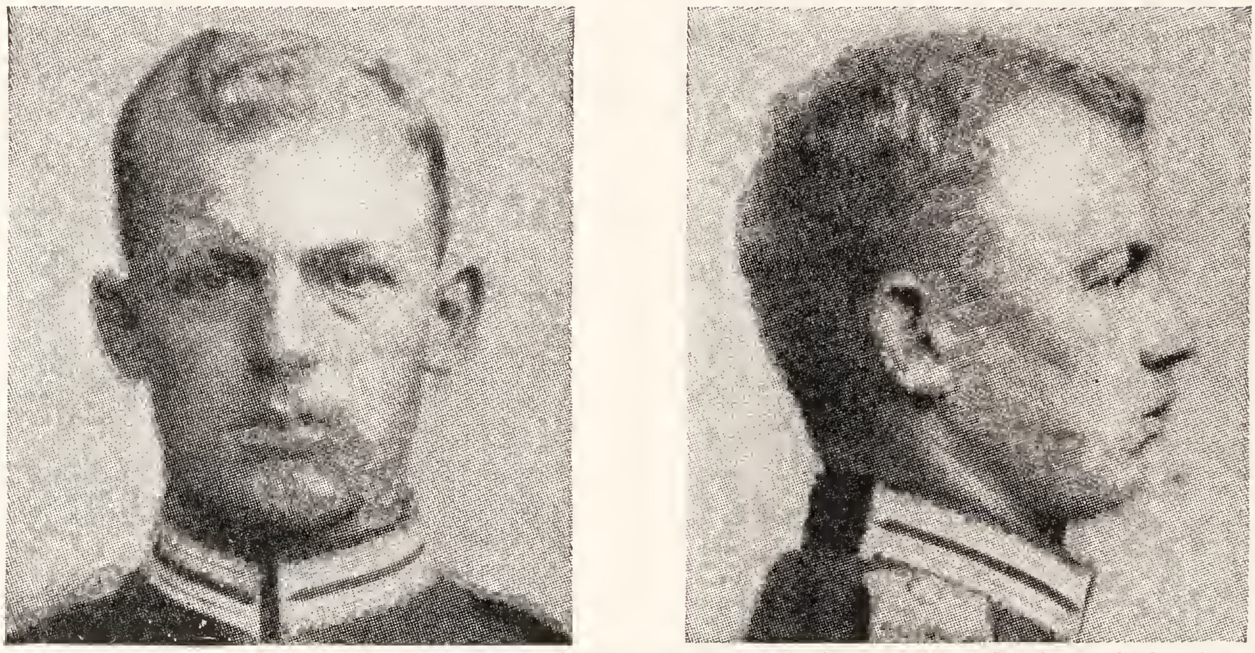


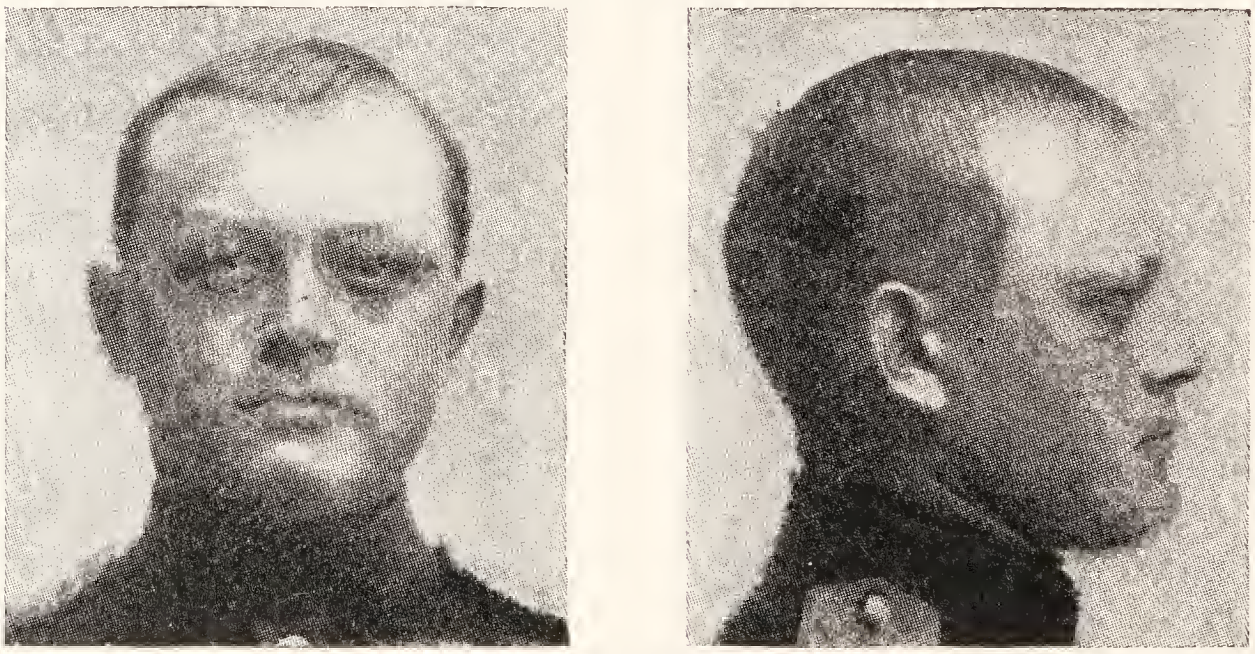
Fig. 92. Diagram showing the possibility of a great dissimilarity in shape, yet with the same Cranial Index. The figures are hypothetical, but drawn to an exact scale the maximum length in each case representing 180 mm. and the maximum breadth 136. This gives a Cranial Index of 75.56 to each one of the three.

index was one of the first results of scientific anthropometry, and produced a deep effect, especially when it was also found that large areas of the earth's surface were covered by a single type. Thus the continent of Asia was inhabited by brachycephals, Africa by dolichocephals, Europe showed two definite zones of dolichocephals, running east and west across the continent, strongly suggesting the theory that Europe was originally populated by a homogeneous, long-headed race, and that these were cut in two across the middle by later migrants from Asia, the continent of short-heads.



Teutonic Type. Hair light, eyes blue. Stature 1.72 m. (5 ft. 7.7 in.). Cephalic index 75

Mixed Type. Hair brown, eyes blue. Stature 1.62 m. (5 ft. 3.8 in.). Cephalic index 83

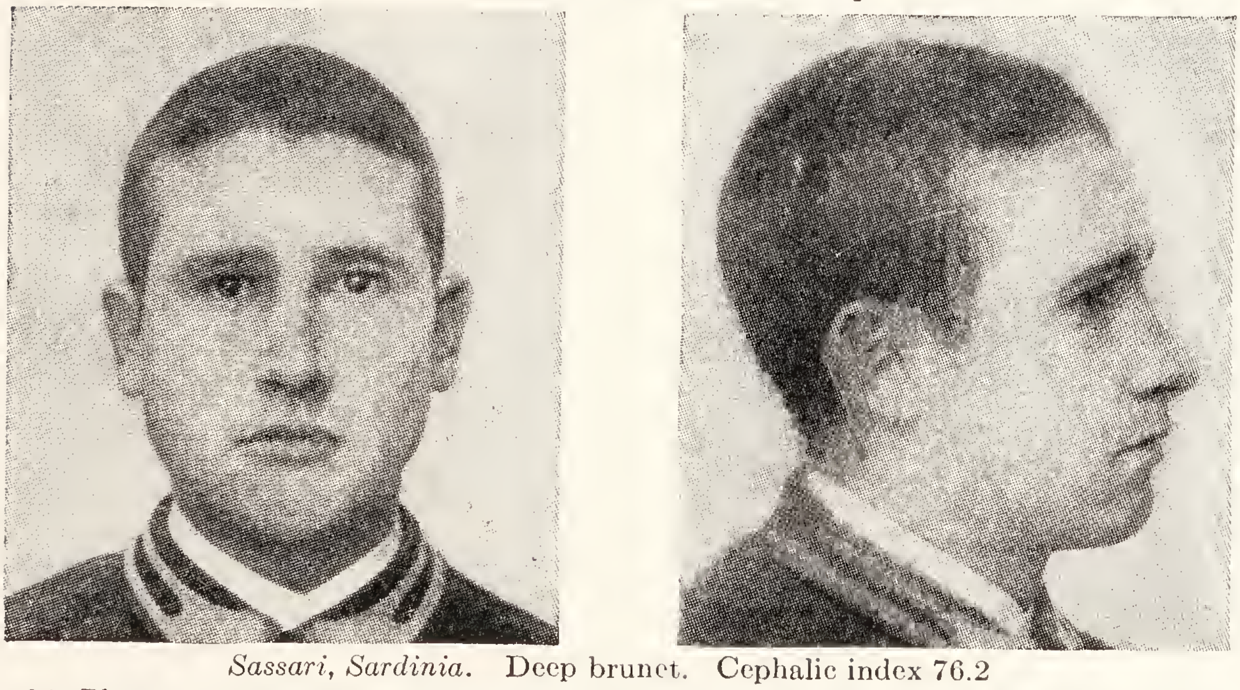


Alpine Type. Eyes and hair dark brown. Stature 1.59 m. (5 ft. 2.6 in.). Cephalic index 86

Fig. 93. Photographs of three German soldiers, showing varieties of head-shapes found in that country. After Ripley.

Piedmont. Eyes and hair light brown. Cephalic index 91.3

Island of Ischia. Eyes and hair dark brown. Cephalic index 83.6



Sassari, Sardinia. Deep brunet. Cephalic index 76.2

Fig. 94. Photographs of three Italian soldiers, showing varieties of head-shapes found in that country. By placing this and the previous figure (93) in sequence, the Germans above, the Italians below, we get a cross section of the entire continent of Europe, having, in order, (1) a pure Nordic type, (2) a mixed Nordic-Alpine, (3) an Alpine type, for the Germans; then for the Italians beginning above with (4) a second Alpine type, then (5) an Alpine-Mediterranean mixture, and (6) a pure Mediterranean type. In this series the physical characters do not all correspond to the political subdivisions. After Ripley.

These short-heads seemed to show a preference for mountain countries, and came to inhabit the mountains of the Alps, running down through the center of the Italian peninsula, following the course of the Apennines. The two long-head peoples, thus cut in two, were divided into a northern and a southern zone, where the average head form is still long, but owing to the influence of climate the complexion, as shown by hair, skin, and eyes, has changed, the northern long-heads, the Teutonic, becoming blond, with blue eyes, the southern long-heads, which can be followed entirely around the shores of the Mediterranean Sea, having brunet hair and brown eyes. This stratification does not at all coincide with the actual, or even the traditional, political boundaries, so that any modern country having a long north and south extension, like Germany or Italy, runs across several "racial" zones, and now consists of the descendants of people once extremely unlike. To illustrate this point, there is in existence a series of photographs of German and Italian soldiers (Ripley, 1899). In the first of these are photographs of German soldiers, the front and side views of three men arranged in order from above downwards. The upper one is a perfect Nordic type, a tall blond, with light hair and blue eyes, a stature of 1720 mm., and a cephalic index of 75. The second man is evidently a mixed type, a Nordic and Alpine cross, with brown hair, blue eyes, and a cephalic index of 83. The next man below him, a pure Alpine, with hair and eyes dark brown, has a cephalic index of 86, as typical of the Alpine stock as the first in order is of the Nordic.

Next in order to this page of German soldiers comes a similar page of Italian soldiers. This series, as we pass south, begins with an Alpine type, with eyes and hair light brown, and with an index of 91.3. Racially he evidently is a blood-brother of the last of the German page, and is equally pure Alpine, but since in modern Europe the political grouping no longer corresponds to the racial, they were on opposing sides in the late war. Below him comes another cross, this time

between the Alpine and the Mediterranean, which presents a man with dark brown eyes and hair, and an index of 83.6. Last in the series comes a typical Mediterranean type, a deep brunet in coloring, and with a cephalic index of 76.2, marking him as dolichocephalic. As the typical Nordic representative is tall, so, although it is not given in the photograph, we may take for granted that this man from Sardinia is short; we may also attribute to him the vivacious temperament of a southern European, while the Nordic representative is equally certainly "earnest, energetic, enterprising, steadfast, solid and stolid, outwardly reserved, thoughtful, and deeply religious" (Keane). Yet in this psychological classification we cannot forget that Keane is also Nordic, and probably dolichocephalic.

The chief exponent of the morphological school is Giuseppe Sergi of Rome, who, although his final conclusions are not very different from what one arrives at by measuring heads and calculating the indices, arrives at it from a different road. Sergi at first asks how many species of lark would an ornithologist find if he did it by measuring the length from the tip of the beak to the tail, and also the wing-spread, and then dividing the one by the other. After this timely suggestion, he reminds one that the zoölogical method of classifying species and varieties is by studying the shapes, and then proposes to study heads by the shapes, without measuring. He finds among the Mediterraneans, who are dolichocephalic, several more or less common shapes, and follows certain types, such as the *Ellipsoides*, the *Pentagonoides* and the *Ooides*, around the entire Mediterranean, as an originally homogeneous race. Rameses the Great, as shown by his mummy, was a typical Mediterranean of the Ellipsoid form. Here we present the tracings of several skulls selected by Prof. Sergi from an eighteenth century cemetery which had been recently cleaned out, as is frequently done in Europe. The length-breadth measurements are also given from which the indices may be calculated. The three just named are

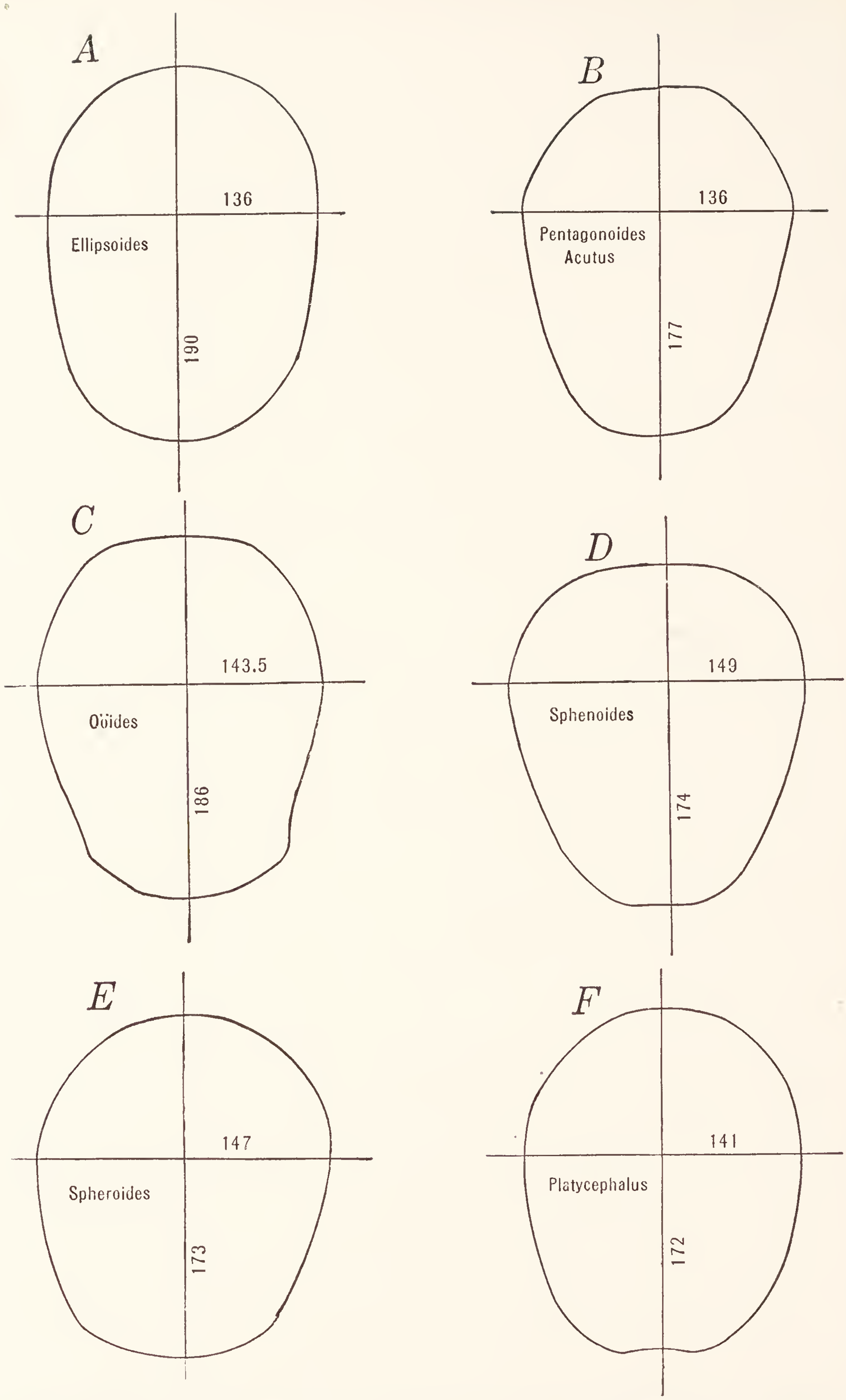


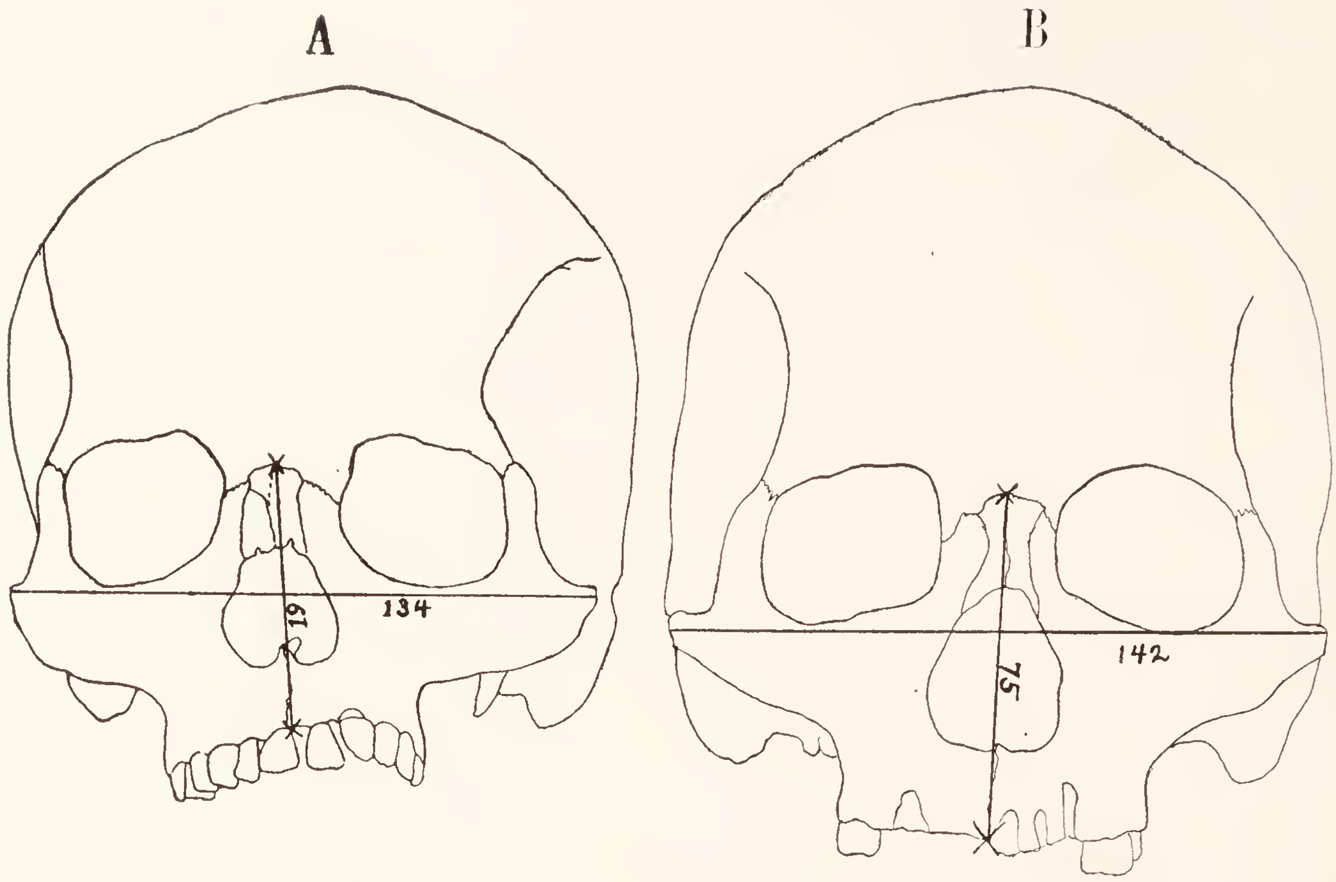
Fig. 95. Diagraph tracings taken around the crania of six modern Italian skulls, selected by Prof. Giuseppe Sergi as typical of the forms represented. The tracings were made, not with an ordinary diagraph point, but with a broad blade, held vertically, so that the outlines are the projection of the outer limits of the skull when viewed from the *norma verticalis*. The types represented by each, and the length-breadth measurements, as taken by the craniometer, are indicated upon the diagrams.

definitely dolichocephalic, and the three others, in shape the *Spheroides*, *Sphenoides*, and *Platycephalus* are equally surely brachycephalic, that is representatives of the Alpine race, who entered Italy originally from Asia, coming down through the mountains. The original people may be possibly the Celts or the Gauls of early Roman history, now inextricably blended with the rest to form the Italian people.

74. Shape of Face. Taught by the experience obtained by the cephalic index and by the positive results by which people are now able to talk with some assurance of dolichocephalic and brachycephalic migrations, the anthropologists then turned their attention to the outlines of the face, and spoke of *facial indices*. By ascertaining the facial breadth and then dividing it by the facial length, faces were classified as *leptoprosopic*, *mesoprosopic*, and *chamaeprosopic*, and these terms soon began to take their places with the already established ones in the descriptions of races.

While, however, the breadth measurement may be easily obtained, using for this the bizygomatic breadth across the cheek bones, the length measurement is an indefinite one, owing to the impossibility of fixing the upper limit. Some have recommended the line of the hair, which limits the forehead, but this is subject to much individual variation, and is furthermore indicative, not of the shape of the face, but of the extent to which the cranium is covered with hair. The glabella is sufficiently precise but leaves out of account the forehead, which forms an important part of the face as a whole. Still another difficulty is met with at the mouth, for unless the teeth are tightly closed, for most people an unnatural position, there may be variation in the position of the jaw and chin relative to the upper face; again, the loss of teeth as a senile change would give a very different facial length from that during earlier years.

In practice it is generally thought best to use simply the measurement of the upper, or superior, face; taking for the



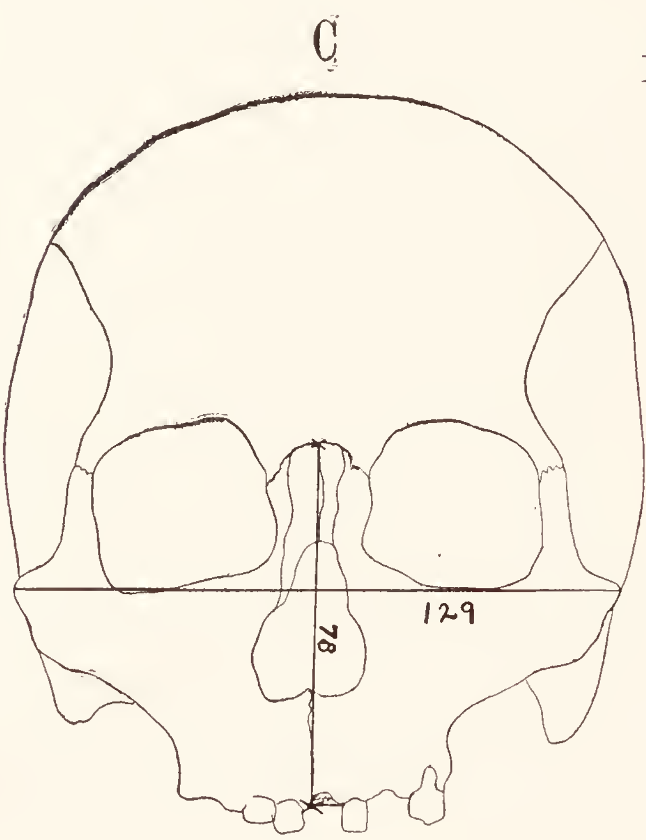


Fig. 96. Dioptograph sketches of three skulls, *norma frontalis*, showing the extremes of facial proportions.

A. Chamaeprosopic. Facial length (nasion-prosthion), 61; bizygomatic breadth, 134. Sup. fac. index, 45.52.

B. Mesoprosopic. Facial length (nasion-prosthion), 75; bizygomatic breadth, 142. Sup. fac. index, 52.1.

C. Leptoprosopic. Facial length (nasion-prosthion), 78; bizygomatic breadth, 129. Sup. fac. index, 60.47.

A and C are Europeans; B is an American Indian from Deerfield, Mass., probably a Pocumtuck. An index of 52 is typical for the aborigines of Southern New England (Knight).

upper limit of the length, the *nasion,* the point of greatest indentation in the profile above the nose, and for the lower limit either the *prosthion,* easily obtained by lifting the lip, or the line of the oral slit, when in repose. The prosthion is somewhat bothersome to the subject, while the oral slit is far easier to use; again, the deepest indentation of the profile is

about as far below the nasion as the oral slit is below the prosthion, so that by taking for the length the two points recommended, the length obtained is practically the equivalent of the nasion-prosthion line used in obtaining the corresponding index upon the skull. With this the bizygomatic breadth may be used as the breadth measure, and the superior facial index calculated by the following formula:—

$$\text{Superior Facial Index (living)} = \frac{\text{Bizygomatic breadth x 100}}{\text{From root of nose to oral slit}}$$

As in the skull a total facial index may be obtained by holding the jaw in a natural position, either closing the teeth or adjusting them in the usual position, and then measuring from the root of the nose to the point of the chin.

Some investigators, on the other hand, prefer for the facial measurements the use of the hair boundary in the length limit. The index calculated from this is called the *physiognomic* index, in distinction from the former, the *anatomical;* it has, however, the two disadvantages of not corresponding to any index taken from the skull, and of being based upon a very variable point.

Aside from all length-breadth indices the shape of the facial outline as a whole, as in the case of the skull, has received some attention. Thus the contour may form an unbroken curve, or may be broken by several angles into a polygon, usually through an excessive development of the cheek bones or of the angles of the jaw. In the first case, the contour may be characterized by such adjectives as oval, elliptical, or round; in the second, rectangular (elongated or square), pentagonal, rhomboidal, trapezoidal, etc.

75. The Eyes. There appears to be a very characteristic type of eye, which is spread in general over Eastern Asia, and includes, besides China and Japan, Anam, Siam, Tibet, and a large part of Siberia (the native stock). It occurs also among a few sporadic peoples in Europe, notably the Finns and Lapps, both of which were originally migrants

from Asia. It is seen also among the Eskimos of the extreme north of America, again a people to whom, for other reasons, ethnologists are inclined to ascribe an Asiatic origin. This is the so-called "Mongolian eye," and is universally known from its delineation in an absurdly exaggerated form in the paintings and sculpture of the Chinese and Japanese. This peculiarity, which is confined to the eyelids and surrounding parts, and has nothing to do with the eye itself, is popularly supposed to be the result of a narrowing of the aperture formed by the margins of the lids, technically the palpebral opening, and the placing of this aperture obliquely, with the outer corners elevated. As a matter of fact this is not strictly true, and the effect is produced in the main by two peculiarities of the upper eyelid; first, the rolling over of a fold of skin across the inner half of the lid so that it hangs over the real edge, and second, the existence of a cross fold, the *spicanthus*, which continues this overhanging part and extends across the inner corner from the upper lid to the side of the nose. (Fig. 97.) As this latter draws down the inner edge of the upper lid, and as the outer corner of the eye is frequently prolonged into a slight upward curve, the effect is often produced of an obliquely placed palpebral opening.

The Mongolian eye, restricted territorially to a large and contiguous portion of Asia, and to extra-Asiatic races believed, through other reasons, to have been originally Asiatic, seems to be a definite racial mark, in fact, one of the few we possess. It is, however, not always present in typical form among the races of which it is a character, and it frequently occurs, as a transitory stage, in infants of the white race.

It has been suggested[1] that the Mongolian eye is correlated with the flat nasal bridge, and a lack of protrusion of the nasal bones. In such a case the skin lacks the customary framework which normally holds it up, and it sags down over the eye in consequence. This idea certainly receives support from the fact of the prevalence of the Mongolian

[1] Stratz; Naturgeschichte des Menschen. Stuttgart, 1904, p. 232.

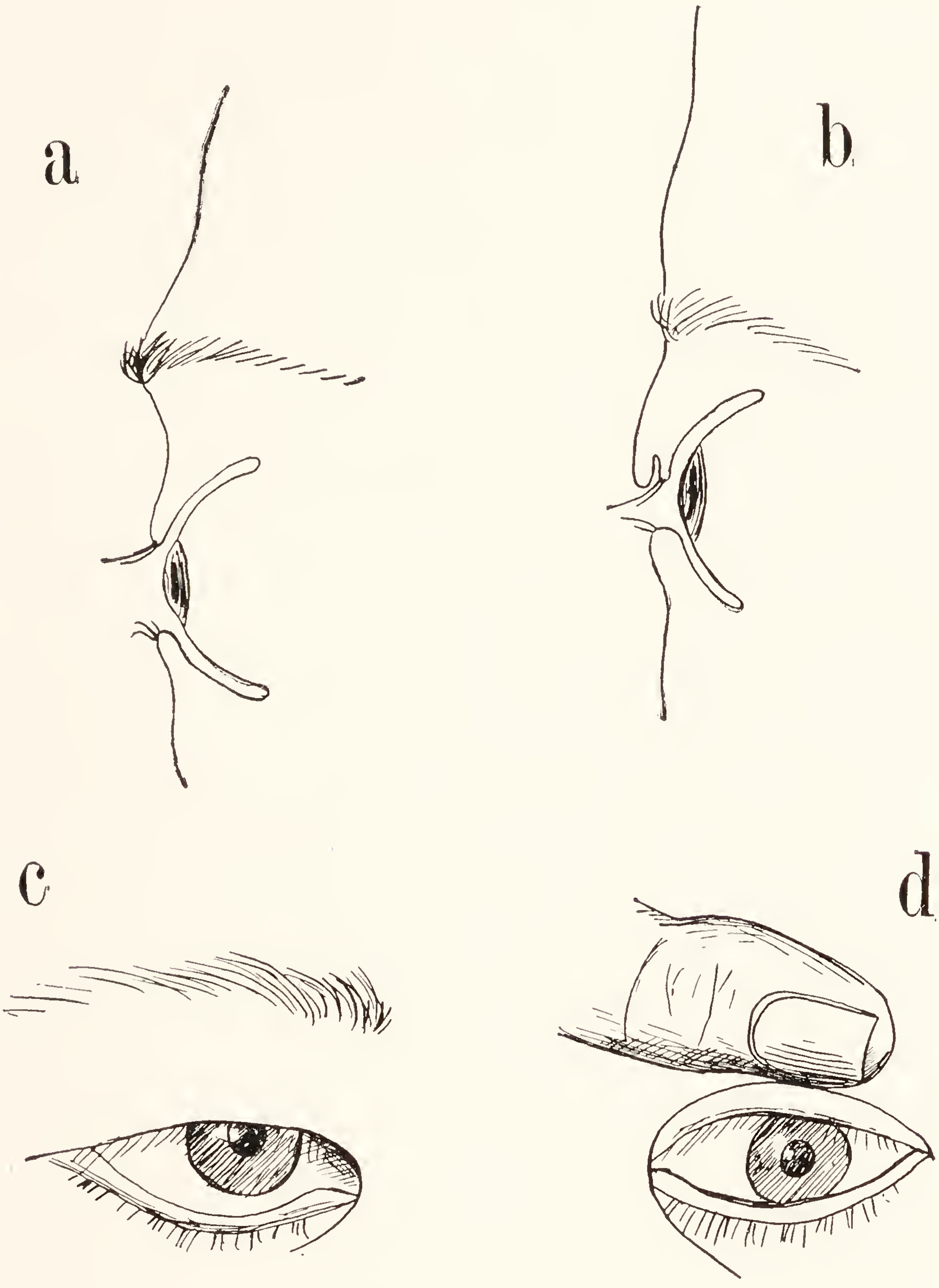


Fig. 97. Diagrams serving to explain the peculiarity known as the "Mongolian eye." In *a* (European) the margin of the upper eyelid, where the eyelashes arise, remains free and uncovered, while in *b* (Mongolian) a fold of skin from above droops down over the edge of the eyelid, concealing it from view. *c* and *d* are the two eyes of a Kalmuk girl of fifteen; *c* in the usual condition, and *d* with the fold lifted up by the finger. This simple treatment brings the eye temporarily into the condition seen in the European, and takes away the Mongolian appearance, but the latter will be at once restored by removing the finger. From Ranke; *a* and *b* after Bälz, *c* and *d* after Metschnikoff.

eye in European infants, with their characteristic flat infantile nose. When, through the development of the bone tissue, the skin of the region becomes lifted up, the effect is similar to that of the finger in Fig. 97, *c* and *d*, although permanent, and the Mongolian appearance is removed.

If this suggestion be established, it follows that it is not the Mongolian eye that is racial, but the peculiar configuration of the bone at the base of the nose and that the conspicuous arrangement of the skin folds is merely a mechanical result.

This Mongolian fold is thus somewhat similar to the peculiarity frequently seen in Europeans, which consists of a similar drooping of the skin above the palpebral opening, not upon the inner, but upon the outer, corner. When this becomes pronounced, as frequently in elderly people, it makes a characteristic triangular eye, with the outer corner involved and the inner free. Singular though it be, this triangular eye also occurs frequently among Asiatics, especially the Finns and Tartars.

The color of the eye is of some importance as a racial criterion, especially in following the course of prehistoric migration. There is, in general, a correspondence between the color of the eyes and that of the skin and hair, consequently a suggestion of an original geographic or climatic reason for color difference. Excepting the pink eye of the albino, which is a defect in development and liable to occur anywhere, the blue eye possesses the least amount of pigment, and is therefore the one intended for the colder regions, with a more oblique sun. From this the hazel, the brown, and the black possess progressively more and more pigment, and belong successively to warmer and warmer countries, where the sun's rays strike more perpendicularly. Where, however, there is a long winter, with much snow, there seems to be need of pigment to shield the eyes from the glare, and as an adaptation to this we have the dark brown or black eyes of the Eskimo. A really black eye, such as is

found among the negroes, is never seen among Europeans, for in the latter the sclera, or "white," is always clear, while in the former it also partakes of the pigmentation, and appears of a brownish yellow; the iris also is of an intense black, unknown in the white race. A deeper pigmentation appears also in the teeth of the negro, and the apparent whiteness in that race, both of teeth and of sclera, are phenomena due to contrast.

As in the case of skin and hair, the eye color has been standardized in the form of a sample set, the "Augenfarbentafel" of Martin.[1] This consists of a set of 16 artificial eyes, contained in a case, and numbered. In using it, the model is placed in a good light and the observer stands at such a distance that the separate spots and zones which make up the iris blend more or less into a uniform color. The eyes of the table are designated by number.

The eye color, presumably because of less importance in adaptation than the color of the skin, is often perpetuated in a given territory for a long time after its introduction, and is frequently left as a very significant result of an historical invasion. Thus the Norman invasion of Sicily is still marked among the inhabitants by the occasional occurrence of a typical blonde, with yellow, or golden, hair, and blue eyes. The light eye, blue or hazel, may also be found there, associated with the more typical Sicilian dark hair and olive complexion, producing a disharmonic type of singular appearance, with the eyes considerably lighter than the skin of the face.

This fact of the persistence of an introduced eye color, which can be seen in cases in which the invasion has occurred within the bounds of history, may be made use of frequently in following a prehistoric invasion or other tribal movement concerning which there is no written record. This study is usually undertaken in connection with the color

[1] Obtained from Hermann, Zurich. Although quite satisfactory for the blues and browns, the set is deficient in some of the grays; it also lacks the greenish-blue, really quite common among the European-Americans.

of the hair, and the data, which must be extensive, are easily collected through the medical inspection of the schools. The results become apparent by reducing the data to percentages, and then constructing maps, upon which these percentages are indicated. As an example of this there is submitted a map of the British Isles, upon which is indicated the distribution of eye and hair color. It shows plainly the present results of a long struggle between two races, the one blond, the other brunette. If there were absolutely no history to rely upon one could not tell positively from this instantaneous picture, as it were, which was the winning race, nor the direction of the movement; but with a certain amount of historical evidence to aid us, we have no hesitancy in assuming that the direction of the movement was from the east towards the west, and that an aboriginal brunet race, once in possession of the islands, was driven to the western borders and capes by the oncoming of one or more blond races from the continent. Undoubtedly these aboriginal brunets were the Iberians (the Picts of history), small and black, and of Mediterranean origin. The invaders were many; first, the Celts, whose coming was almost prehistoric, and who invaded Britain from Brittany, and then the various Nordic peoples, Scandinavians from the north and Germans from the west. Now all of these people would be classed as blond, in contrast to the little dark Iberians, and thus the blond element came in successive waves, but from the same general direction. Of the later struggles when the Germanic races invaded the Celtic Britons there is naturally no record left in hair and eye color, save, perhaps, in the scattered Celtic red hair and freckled skin, but we know from history that the results were almost a repetition of the first, and that the Celtic speech maintains its last strongholds in the same geographical localities where the brunet Iberian peoples made their final stand, namely, in the western island, in the peninsulas of Cornwall and Wales, and in the Scotch Highlands, where the mountains

furnished a natural retreat. Thus it happens, that although representing two distinct movements, the areas of brunetness and of Celtic speech are somewhat coincident. The darker area about London is simply an indication of the general collection of people of all sorts about a great metropolitan center, and has no significance in racial distribution. (Fig. 101)

The results obtained through physical data, like those just considered, give a far more correct account of a great historical movement than any written document, for they show exactly what has actually been accomplished in the way of racial movement. To the recorder of history a political replacement of one government for another, the substitution of one flag, or one language for another, counts as an annihilation of the one and the supremacy of the other; from the standpoint of the anthropologist such a sweeping change seldom if ever takes place, at least within reasonable limits, and a foreign civilization may be imposed upon a people without materially altering the physical features of the population. A language, for instance, may be easily replaced, sometimes with scarcely a trace of the supplanted one, but the shape of the head, the color of the eye and hair, last as long as the people do, and furnish sure and faithful data of racial struggles and racial migrations.

In one other respect is the eye used in descriptive ethnology, and that is in respect to its size. This character may be measured most accurately on the skull, by the usual method of measuring the length and breadth of the orbit, and calculating an index from these. From these data a skull, or an entire race, may be divided into chamaeconch, mesoconch, and hypsiconch, the first embracing those with an orbital index up to 80.0, the second one between 80.0 and 85.0, and the third an index above 85.0.

The native Australians are chamaeconch, the Guanches, the inhabitants of Southwest New Guinea, and the Bavarians are mesoconch, and the main mass of humanity otherwise is hypsiconch.

76. The Nose.[1] As with the eyes, certain important characters of the nose can be obtained from the living, while others are obtained from the nasal fossa of the skull.

A nose, standing out from the face by itself, built up from the nasal bones and cartilages, and lodging the anterior nares, is an unusual development among animals, and among the Primates occurs only sporadically, notably in the absurd "Nasalis" monkey, *Nasalis larvatus*, a Lasiopygid from Borneo. In most apes the nostrils lie flat on the face or nearly so, and the marked elevation characteristic of Man is thus another case of sporadic development, like the one just mentioned. Judging from the skull of La Chapelle-aux-Saints, *Homo neandertalensis* possessed a nose of still greater prominence than is found in any modern race, so that the flat nose of the Mongolian, and the still flatter one of the Negro, are to be considered as the results of a development away from the earlier condition rather than the retention of the primitive.

As in the case of the skull the relative breadth of the nose may be obtained and put in the form of an index, by measuring the length and breadth. While, however, the length measure, from the bottom of the re-entrant curve above the nose to the base of the septum below, is practically the same as the nasion-nasospinale length upon the skull, the breadth, taken between the outer surfaces of the wings of the nostrils, is always considerably in excess of the breadth of the piriform fossa; so that the indices on the living are higher than in the skull, and have quite different values.

[1] Hovorka, O. von; Die äussere Nase; eine anatomisch-anthropologische Studie. Wien, 1893.

Hoyer, H.; Beitrag zur Anthropologie der Nase. Morphol. Arbeiten, 1895, pp. 151–177.

Wiedersheim, R.; Beiträge zur Kenntniss der äusseren Nase von Semnopithecus nasicus. Eine physiognomische Studie. Zeitschr. Morphol. und Anthropol., Bd. III, 1901, pp. 300–350.

Spurgat, F.; Die regelmässigen Formen der Nasenknorpel des Menschen, etc. Anat. Anz., VIII, 1893.

Bertillon, A.; De la morphologie du nez. Revue de l'Anthropol., 1887.

Compared with each other the two Nasal indices are valued as follows:—

	Nasal Indices	
Classes	*On the Skull (Broca)*	*In the Flesh (Topinard)*
Leptorrhine	Up to 47	Up to 70
Mesorrhine	47.1–51.0	70–85
Platyrrhine	51–58	85 100
Hyperplatyrrhine	Above 58	Above 100

Although the exact correspondences between the two indices have never been established upon the same individuals, it seems fair to suppose that the values of the indices forming the limits between the classes are about equivalent. This would make 47=70, 51=85, and 58=100, in which it is seen that the units have different relative values in different parts of the scale. Thus the mesorrhine class is covered by only four units in skull indices, which are equivalent to 15 units on the face, while in the platyrrhine class seven skull units are the equivalent of 15 units on the face. There is evidently need of correlating these values upon the same individuals, an investigation that can be carried out upon the cadaver in the dissecting room.

It is noteworthy that, whatever the usual nasal index of the adults, the infant nose is peculiarly flat and broad. In a study of a series of European babies, together with their mothers, Blind found in the former a range of indices from 82 to 143, the last an extreme of breadth never met with in adults of any race. The average index, 107, is like that of adult Ashantee negroes, or of Australians. In percentage of occurrence the types of nose, of both the babies and their mothers, were as follows:

Class of Nose	*Babies*	*Mothers*
Leptorrhine	0	43%
Mesorrhine	3%	53%
Platyrrhine	30%	4%
Hyperplatyrrhine	67%	0

That this flatness of nose among infants may have some

bearing upon the frequent appearance of the Mongolian eye among infants has been already considered in the previous section.

The following list of average nasal indices in living races is taken largely from Deniker (Races et Peuples de la terre, Appendix III).

NASAL INDICES FROM THE LIVING

A. Leptorrhine (less than 70)		
Armenians	60.4	(Pantioukhof)
Brahmins, of superior caste	63.0	(Crooke, Drake-Brock)
French, blond, dolichoceph. type	63.0	(Collignon)
Anglo-Scotch	65.1	(Beddoe)
Kabyles, Northern coast of Africa	66.5	(Preengreber)
French, general average	67.3	(Collignon)
Sikhs of India	68.8	(Ripley)
B. Mesorrhine (70–84.9)		
Tunisians	72.0	(Collignon)
Kalmuks of the Volga	74.7	(Deniker)
Todas (India)	74.9	(Thurston, Jagor)
Sioux Indians	75.9	(Deniker, etc.)
Hindus (N. E. provinces)	80.9	(Ripley)
Chakama, Bengali	83.9	(Ripley)
Zuni Pueblo Indians	84.4	(Ten Kate)
C. Platyrrhine (85–99.9)		
Polynesians	89.9	(Collignon)
New Caledonians and New Hebrides	93.8	(Collignon)
Fulbe, Sudan	95.3	(Deniker)
Negroes of Tunis	96.3	(Collignon)
D. Ultraplatyrrhine (above 100)		
Negroes of the Zambesi	101.5	(Collignon)
Ashanti	107.6	(Deniker)
Australians	107.6	(Collignon)
Negroes of Angola	107.9	(Deniker)

A second aspect from which the living nose may be studied and compared is a rather inconvenient one to employ, but is of great ethnological value, and correlated in a general way with the classification just described. This is a

view of the nose from underneath, seen at best advantage when the subject is lying in a recumbent position. This aspect is a plane of triangular contour, the triangle being very broad and flat in a platyrrhine nose, its altitude rising as the nose approaches a higher index. The most striking feature, however, is the position and shape of the nostrils,

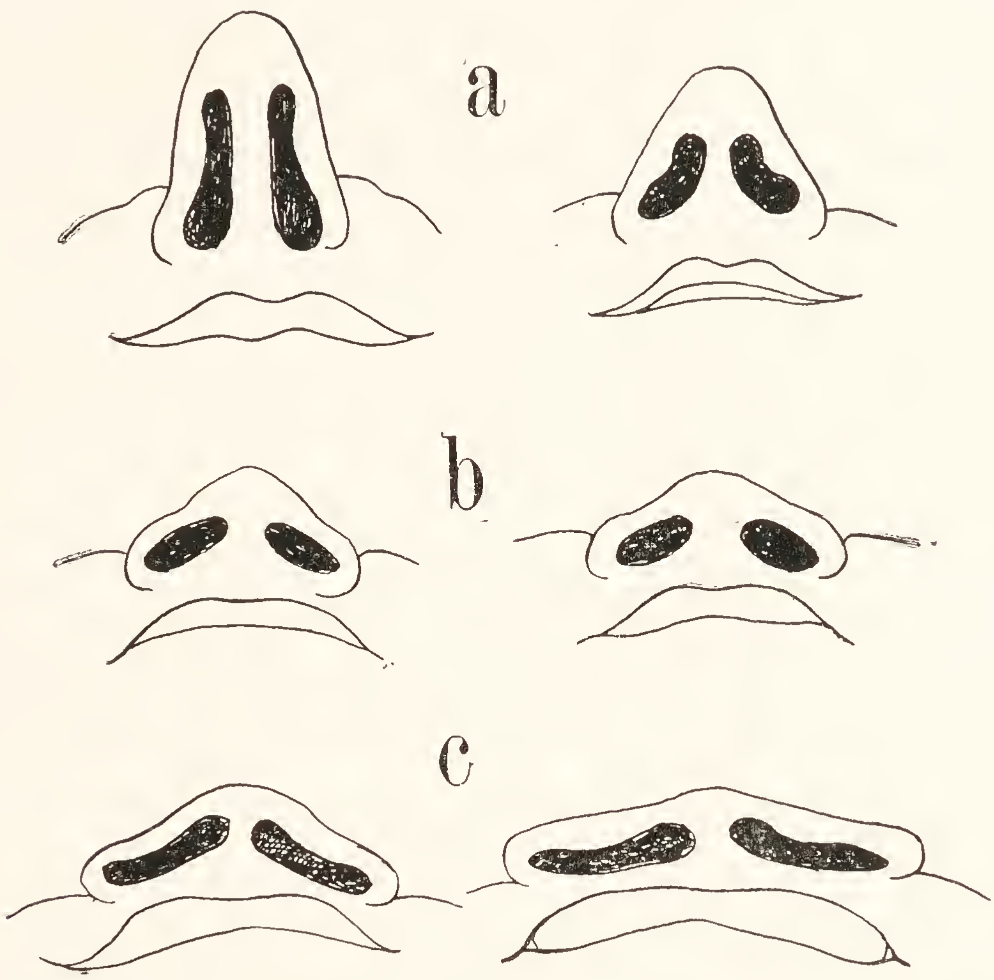


FIG. 98. Diagrams of the various shapes of the lower plane of the nose, as seen from beneath, with the characteristic shape of the nostrils in each.
a. Extreme of the Leptorrhine type.
b. Extreme of the Mesorrhine type.
c. Extreme of the Platyrrhine type.
After Topinard.

which, in an extremely leptorrhine nose, appear elongated dorso-ventrally, with their axes nearly parallel, and slightly converging towards the tip, while in the extreme platyrrhine type they are extended laterally, with their axes in nearly the same straight line. In the intermediate grades the axes of the nostrils are placed more or less obliquely, so that a complete series occurs, with the axes passing through all the angles between the extreme positions. It must be noted,

however, that narrow and elongated nostrils lie only at the ends of the series, and become about circular in the intermediate grades.

These relations may be expressed by comparing the measurement of the breadth of the nostrils (the breadth measurement of the previous index) with that from the tip to the base of the septum, antero-posteriorly, thus forming an Elevation Index, or Antero-posterior Index. This index, in observations of European babies, varied from 30 to 86, with a mean of 53; and in their mothers from 56 to 117, with a mean of 87. The shapes of the nostrils in the same occurred in the following percentages:—

Shape of nostril	*Babies*	*Mothers*
Slit-like, perpendicular to upper lip	13%	81%
Obliquely placed, oval	39%	14%
Triangular	22%	1%
Long oval, parallel to lip	26%	4%

The contour of the back of the nose, as seen in profile, is of some value, but has been worked out mainly in the white

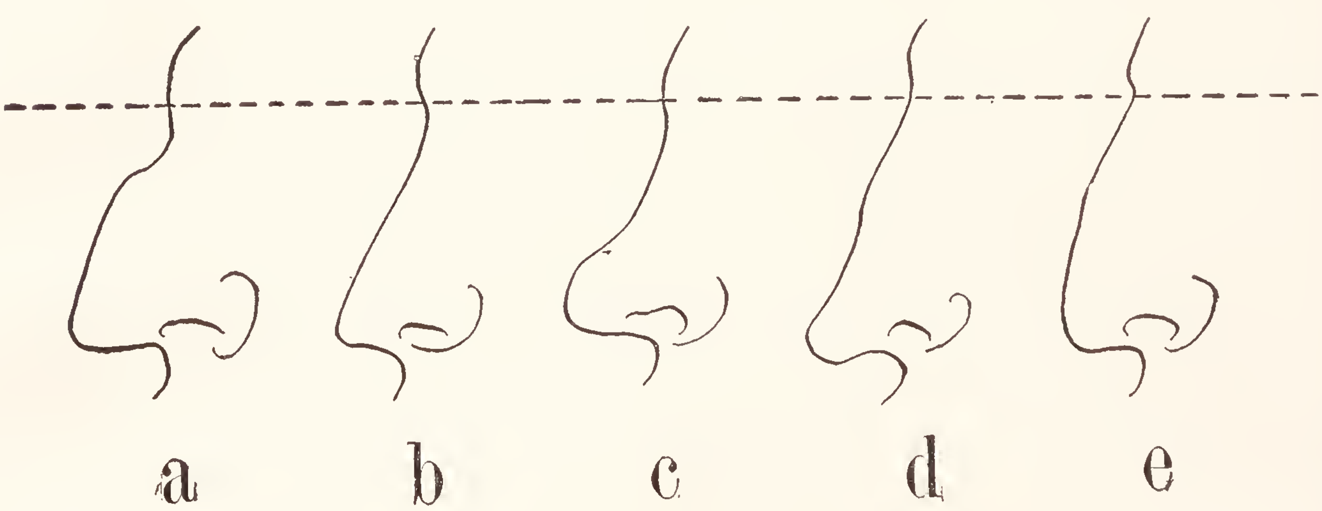


Fig. 99. Characteristic nasal profiles in the European peoples.
a. Aquiline. *d.* Hawk.
b. Straight. *e.* Semitic.
c. Pug, retroussé.
After Topinard.

race, where numerous types have been established. They seem to be, however, mainly individual or family characteristics, and of little significance as racial distinctions. An

exception to this, which will readily occur to the reader, is the Semitic type, which is found, not only in Jews and Arabs, but also, if we can judge from ancient sculpture, was characteristic of the early Semitic civilizations in the valley of Mesopotamia. This Semitic type of nose is popularly considered to be large and hooked or humped, but these are not fundamental peculiarities, and indeed are not by any means universal. Rather is the salient character to be found in the lateral wings, which both prolong and accentuate the groove

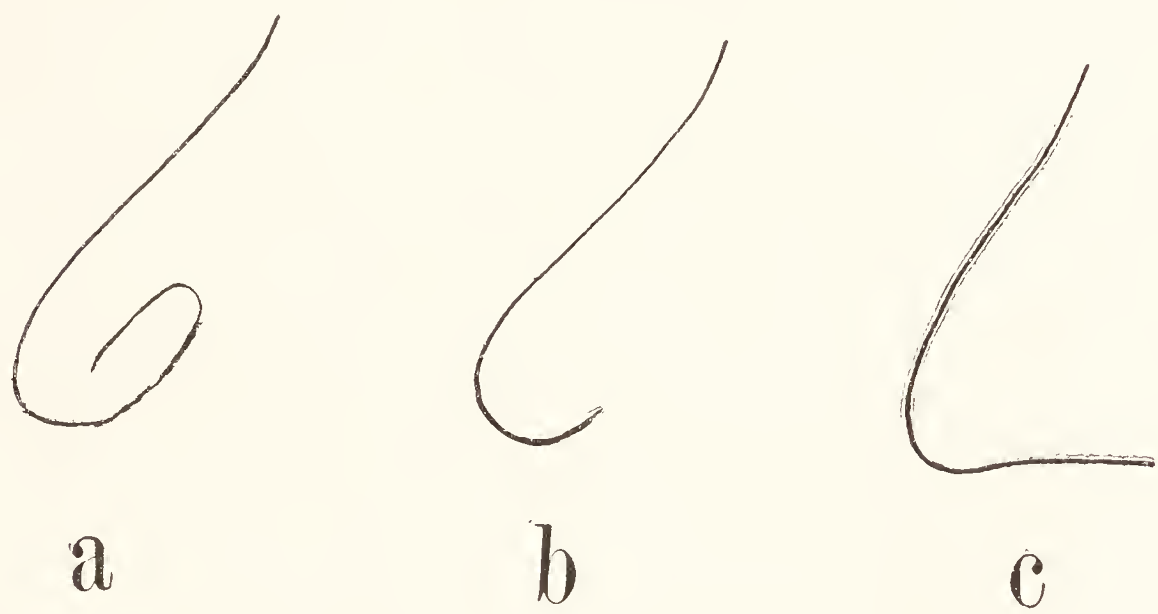


Fig. 100. Figures to illustrate the essential peculiarities of the Semitic nose. This is shown in *a*, which is simply a figure 6 with a rolled and open base. The Semitic character vanishes if the final curve, defining the wing of the nostril, is removed, and merely a large nose, as drawn by making a figure 7 upside down, is not Semitic in any respect (*c*). From Ripley, after Jacobs.

over the nostril. If, for example, we represent a nasal contour by a figure 7 inverted, be it ever so big, it does not suggest the Jew; but if we represent the contour by a figure 6, the suggestion is instantaneous. Caricature though it be, the Jew is contained in this curve alone, and other lines are not necessary for his delineation.[1] This instance is of

[1] Jacobs, Joseph; On the Racial Characteristics of Modern Jews. Journ. Anthropol. Inst., Vol. XV, 1886, pp. 23–62. (Quoted by Fishberg; The Jews, 1911, p. 85; and by Ripley, The Races of Europe, 1899, p. 395.) The original quotation is as follows:—"Artists tell us that the very best way to make a caricature of the Jewish nose is to write a figure 6 with a long tail; now remove

interest, first, as a definite, perhaps the only, case of a racial character in the form of the nose, and secondly, as showing the inability of people in general to select the true lines in the case of form differences. That, however, it does not escape the notice of trained artists, in the habit of selecting the salient characters for use in their delineations, is well shown by the emphasis placed upon this feature in the old bas reliefs from Nineveh and Babylon, the work of Semitic sculptors. In Egypt also there is an ancient stone carving representing the men of many nations paying tribute to an Egyptian king, and among these, in which several racial types are clearly delineated, appear the men of some Semitic nation, characterized by this trait. The criminal anthropologists, like M. Alphonse Bertillon, in their endeavor to describe individuals for purposes of identification, have paid much attention to the nose, but the peculiarities noted by them, although classified in a thoroughly scientific manner, are of little value to the ethnological anthropologist, as they deal with variations that are individual, rather than racial. Characteristics that may be found to have a racial significance have been grouped by Topinard in the following classification:

Maximum length, Maximum breadth — Transverse Index
Maximum projection, Profile — Antero-posterior Index

Dorsum:
- Angle of Inclination: Straight; Bent
- Direction: Convex (Aquiline); Concave (Pug, Retroussé); Roof-like
- Form: Rounded; Flattened

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the turn of the twist and much of the Jewishness disappears, and it vanishes entirely when we draw the continuation horizontally. We may conclude, then, as regards the Jewish nose, that it is more the Jewish nostril than the nose itself which goes to form the characteristic Jewish expression."

- Base
  - Lobule
    - Distinct (Pinched off, Trilobed)
    - Not distinct
    - Overhanging the nostrils
  - Wings
    - Approaching
    - Divergent
  - Nostrils
    - Form
      - Elliptical
      - Rounded
      - Special
    - Major axis
      - Small
      - Large
    - Their plane directed
      - Downwards
      - Forwards
      - Backwards
      - Outwards
    - Direction of major axis
      - Antero-posterior
      - Oblique
      - Transverse

77. The Mouth and Lips. These organs show great individual variation and contribute largely to the expression of the face; there are, however, certain peculiarities of racial significance, which lie deeper than the individual differences, and which impose themselves in different degrees upon all the members of a given human family.

As seen in the living simian apes the primitive form of mouth is one in which the lips are thin and very flexible, with the mucous surface *wholly internal, and not rolled out upon the outer surface of the face.* Owing to the considerable amount of prognathism the mouth slit is curved and very extensive, i. e., wide; and the upper lip is broad, in order to cover the extent of maxillary surface between the base of the nose and the tips of the upper teeth. Since in *Homo neandertalensis* this interval is also broader than in modern man, with the piriform opening higher up, it is altogether probable that the lips of this species were more simian, that is, thin, with the upper one broad and flexible.

As a definite departure from this primitive condition there

must be viewed a characteristic often found in recent man, namely, a rolling out, technically an *eversion,* of the mucous surface at the free edges of the lips, making a broad mouth, up and down, as seen from the front. This peculiarity seems always connected with an appreciable thickening of the free edge, and it is in this latter character that we may see a reason for the former. As these characters are both so unlike those of the primitive stock from which the modern species was derived they must be considered as specializations, and the fact that they occur in the highest degree in the negro show here, as do so many other bodily peculiarities of these people, a high specialization rather than a primitive condition.

It is a matter of some curiosity that the painters of the Pre-Raffaelite school, especially Rosetti and Burne-Jones, have seized upon this feature of lip eversion as a characteristic of their faces, especially in the portrayal of spiritual young women. In this they are hardly consistent ethnologically, however, for it is needless to say that they do not add also the thickness of lip which in nature is bound to accompany the eversion of the mucous surface. It may be noted also that in his famous painting of *Pithecanthropus* Gabriel Max has also emphasized lip eversion, but has consistently added the thickness at the edges, as seen in the profile view of the male. It is hard to say whether he follows here the popular idea which treats negro characteristics as primitive, or whether he is influenced by the Pre-Raffaelite artists. The face of the female, with its oval contour, suggests the latter idea, and makes the sin that of an artist rather than that of a scientist; yet it is unfortunate that, in a painting bound to exert so wide an impression upon interested though uncritical people, this error concerning the supposed primitive character of thick, outrolled lips should have been perpetuated.

From the study of the more primitive types of simian mouth it is a little difficult to understand the thick everted

type of the human lip. In the apes the prognathism of the jaws is accompanied by a considerable width in the upper lip, as is shown to an exaggerated extent in the orang-utan, but there is no trace of either eversion of the mucous surface or of an appreciable thickening of the edges. In comparing the mouths of the various human races it is undeniable that it is the white race, rather than the black, which approaches the nearest to the primitive type, even including, in occasional cases, the broad upper lip. It is in the white race alone, or perhaps occasionally among the Indians of North America, that we meet with the narrow type of mouth, with thin, compressed lips, showing little or no mucous surface; yet it is this very type in which the characters of the mouth of apes and monkeys come nearer finding expression.

78. Skin Color. It is hard to convince a person of European blood, especially a North American, that a dark skin is not an indication either of race or degree of culture, but simply an adaptation due to climate, developed by all people long subjected to a tropical sun. This, like all other adaptations, is advantageous to the possessor and is in part the means which enables the natives of these regions to live and work under a sun which prostrates the white colonist who comes there as the representative of a "superior" race. As it is probable that Man, like the other Primates, was primarily tropical and has spread to the colder climates only by virtue of the invention of clothing, with its protective possibilities, it follows that a dark skin is more natural to the species than a white one, and that the latter is a secondary modification. In other words, the significance of skin color is purely a biological one, and has in itself no relation to culture.[1]

It is often urged in opposition to the principle of skin color

[1] Woodruff, C. E.; The Effect of Tropical Light upon White Men. Rebman Co., New York, 1905, pp. 1–358.

Ammon, O.; Ueber die Einfluss des Sonnenbads auf die Hautfarbe des Menschen. Zeitschr. Morphol. u. Anthropol., Bd. IX, 1905, pp. 57–58.

as an adaptation that white men have now inhabited the tropics, and black men the cooler countries, for several centuries without changing the color of either, but the geologists of a generation ago had to meet similar objections to their theories of world formation, namely, that the progress could not be directly observed. To meet this objection it is only necessary to refer to the chronology of human history, which gives ample time even for greater modifications; it may also be remembered that all adaptations are slowly acquired, and when acquired are slowly modified. It seems, moreover, by no means certain that skin color has remained unmodified in the instances cited, even within the short period during which whites and blacks have changed places, for the Creoles, or people of European parentage born in the tropics, are, even after two or three generations, markedly darker than the inhabitants of the mother country, and the negroes of the United States are certainly lighter than the natives of the Guinea Coast, the original home of the most of the North American negroes. In this latter case there is undoubtedly a considerable admixture of white blood, but in the first instance there is, as a rule, no such condition. A significant fact in the present argument is that, in Central Africa, and in other regions exclusively inhabited by black people, the mountaineers, that live at high altitudes, where the conditions are like those of the temperate zones, are light in color or even quite white, although of the same blood as their neighbors of the surrounding lowlands. The same principle, that skin color is an attribute of climate rather than race, is also shown in the case of the American aborigines, which, with the exception of the Eskimos, belong to a single homogeneous race, and among which there is a wide range of skin color, for the most part apportioned exactly to the climate as affected by either latitude or altitude above sea level. In this distribution the range of color lies between extremes almost as great as between the European and the negro.

Anatomically the skin, when formed of its essential elements alone, is almost without color, but receives a pinkish tint from the underlying blood-vessels, which are seen through it. Only in a few cases, however, as in many Scandinavians, is this simple condition seen; in all other cases there develops a variable amount of a dark coloring matter known as pigment, which collects mainly in the cells of the lowest layer of the epidermis, but originates in the corium. It differs considerably individually both in quantity and in distribution, especially in the white race, where marked differences may occur in members of the same family. Where it is not very abundant, and especially when kept from the light, as on an habitually covered region, it remains very pale in color, and is hardly appreciable; when, however, such skin is exposed to the sun, the pigment darkens, and the skin becomes "tanned." In some individuals, especially those members of the white race that possess red or auburn hair, this pigment is distributed irregularly over the surface in small but definite areas that lie in a pigment-free ground, and these spots, indistinguishable from the rest of the skin so long as it is kept away from a strong light, become brought out, or "developed," by the sunlight, producing what are known as freckles, really small irregular areas of tan, surrounded by an untanned surface. A wholly pigmentless skin, naturally white or pink, is incapable of tanning or freckling, but when unaccustomed to the sun may "burn" when exposed to it, as is also the result in many other cases. Where the accumulation of pigment is very large, it darkens soon after birth, and forms a brown or black skin in accordance with its amount and quality.

A certain amount of light seems necessary for the bringing out of the pigment, even in negroes, for the infants of this race, when first born, are of about the same color as white infants, and darken only after several hours or days. In these, and in other races, there is little or no pigment in the palms of the hands and the soles of the feet, which

remain permanently light. There are also certain areas, as the back and shoulders, and the dorsum of the arms, which, even in negroes, show a more intense pigmentation, and are capable of becoming distinctly blacker than the rest of the body. As these are also the areas most exposed to the sun, they suggest both the adaptive use of pigment as a protection from the solar rays, and also the possible cause of this distribution. It appears as though the sun, perhaps through its chemical rays, has a harmful action upon the subcutaneous parts of the body, when allowed to reach them, and that to prevent this the aborigines of the warmer regions have developed, as a biological response, an impervious layer of pigment just beneath the surface, for the purpose of cutting off the harmful rays from the deeper parts. Thus in a given race the thickness of this layer and the intensity of its color become exactly adjusted to the habitual intensity of the sun in the natural habitat.

Aside from its quantity and depth of color, pigment exists in many color varieties, so that the skin color of the various races differs in other qualities than in simple intensity of pigmentation. To designate these with precision in ethnological description Broca established a schedule of standard colors distinguished by numbers, much like cards of sample paints. This has proved of much value, yet is open to the difficulty in accurately duplicating the colors of the original list and in the extreme liability of the samples to change their color with time.

Another form of standard colors has been prepared by v. Luschan, under the name of the "Hautfarbentafel." This consists of small pieces of opaque glass in 36 different shades, placed in a convenient frame with numbers attached. Not only is the form a more convenient one, but the glass has the considerable advantage that its colors are permanent.

The principle of the color wheel is also resorted to for the purpose of describing skin color, and possesses the advantage that the number of shades and tints is limitless. It

requires, however, the use of standardized colors in preparing the discs, as otherwise the results would naturally differ. This can be used in two forms; that of the usual upright wheel, clamped to a table, and made to rotate by means of a handle, and that of the simple color top, which is spun with thumb and finger like a teetotum. In each the colors are obtained by exposing various areas of certain pure colors, like red, white, or yellow, and then stating the exact number of degrees used of each. Thus the Davenports, in their work upon the skin color of the negro, used the color top, and expressed the desired shades by formulae in which the numbers used are the proportionate parts in 100. Thus a very dark negro gave the formula N 75. Y 3. R 20. W 2. (N = black; Y = yellow; R = red; W = white.) The color of a tanned white wrist gave the formula N 8. Y 9. R 50. W 33. and a second black negro gave N 68. Y 2. R 26. W 4. In the same way may be expressed the average color for a given race thus (approximately):—

English	N 15.	R 35.	Y 15.	W 35.
Sicilian	N 32.	R 50.	Y 18.	
Tagalog	N 50.	R 35.	Y 15.	
Japanese	N 25.	R 48.	Y 27.[1]	

An approximate descriptive classification, which divides the color of the skin into four fundamental varieties, with a sufficient number of subdivisions to enable one to arrive at a considerable degree of accuracy, is the following, based upon the diagnosis of Topinard:—

CLASSIFICATION OF SKIN COLORS.

I. WHITE. (Europe; Africa North of the Sahara; Western Asia)
- (*a*) rosy (Scandinavian)
- (*b*) florid (English)
- (*c*) brunet (Southern French)

[1] The color wheel and top are manufactured by the Milton-Bradley Co., Springfield, Mass. The "Hautfarbentafel of v. Luschan is carried by Hermann, Zürich.

(*d*) swarthy (Spanish)
(*e*) olive (Sicilian)
(*f*) bronzed (Moors)

II. YELLOW. (Eastern Asia)
(*a*) white, almost like Europeans (some Japanese)
(*b*) pale yellow (Japanese, Chinese)
(*c*) gingerbread color (Southern Chinese, some Malays)
(*d*) brown (Malays in general)

III. RED. (The two Americas)
(*a*) white, like a South European (Mountain Indians of Northeastern Canada, and of the Andean Highlands)
(*b*) olive-brown (Peruvian Indians)
(*c*) dark reddish brown (Caribs)
(*d*) black, almost like an African negro (Indians of Southern California; Tropics of South America)

IV. BLACK. (Central and Southern Africa)
(*a*) yellow gray, color of old leather (Hottentots)
(*b*) rhubarb yellow (Fulba)
(*c*) dirty yellow (Obongo)
(*d*) reddish brown (Zulu)
(*e*) coffee-colored, "cafe-au-lait" (Fan, Makololo)
(*f*) ebon, sooty (Sudanese)

In this classification there is often a close correspondence between two different subdivisions, as, for example, the reddish brown of the Zulu and Carib (III *c* and IV *d*), or between the "white" of I, II, and III. In general, however, even in these there is a little of the fundamental color used for the main divisions, and the "white" of the Japanese and the Canadian Indian have, respectively, a suspicion of the yellow or the red which form the underlying color of their races. The geographical specifications accompanying the four main subdivisions are those of the home land of each type.

79. THE HAIR. The hair is one of the most valuable features for ethnological study, as it is capable of much variation, and the special characters are very constant

in a given race. The hair may be compared in a number of ways: general appearance, size and shape of the single hairs, color, length, distribution, and amount, in all of which respects there are important racial differences. Concerning the first of these, the appearance of the hair as a whole, the main types may be set forth in the form of a table, in which the technical terms are given in several languages, to insure an exact correspondence:—

Human Hair, Classified in Accordance With its General Appearance.

I. Straight———droits, lisses———straff, schlicht——— Ex. Chinese; Amer. Indian.

II. Wavy————ondés, ondulés————wellig———Ex. most Europeans; Veddahs of Ceylon.

III. Curly, frizzly———frisés—————lockig————Ex. some Europeans; some Australians.

IV. Woolly————crepûs, laineux———kraus, spiral-gerollt—Ex. most negro races.

IVa. lophocomi (with separate tufts)—Ex. Hottentots; children of most Negroes.

IVb. eriocomi (tufts interlaced, forming a solid mat)—Ex. adult Negroes in general.

These types naturally shade somewhat from one to the next, but are yet capable of a fairly exact definition. The first type, straight hair, is literally what the word implies, quite without curves or waves, and is seldom or never seen among people of European origin. Hair that is thrown into gentle curves, that follow one another in opposite directions, constitute the second type, and is termed wavy. When these curves are short and the turns abrupt, the general appearance is similar to that of the third group, the true curly hair, but the two may always be distinguished by examining a single hair from the end and seeing if the curves form complete spirals or not. If they do the hair is curly; if they do it rarely, or not at all, it is simply wavy; also this completion of the curl often occurs at the ends of long

hair that is properly classified as wavy. Curly hair, the third class, is a true spiral in form; that is, when the individual hairs are viewed from the end the coils are seen to make complete turns. In typical curly hair, as distinguished from the next class, the diameter of the spiral is considerable, 2-4 cm., but as this type approaches the next this dimension becomes less; until, when the coil or spiral is very small, and the turns fit closely upon one another, the hair becomes genuine woolly hair, and is put into the fourth class.

Of this latter there are several varieties. In the *lophocomi* each curl or tuft is quite distinct, and separated from the adjacent tufts by definite partings; in the *eriocomi* the tufts lose their identity and become interlaced to form a solid mat in which the tufts are distinct only at their distal ends. The first of these, called by the French "cheveux en grains de poivre," is evidently the more primitive form and as such is seen in the children of most negro people, and in the adults of the Bushmen and Hottentots, known from other reasons to be primitive representatives of the black race. The other develops secondarily from the first and is the condition seen in the adults of the majority of negroes. There is also a third variety, perhaps a strong development of the second, in which the mat of hair is extensive and stands up naturally like a thick pompadour over the entire head. This condition is seen in the Papuans, and is termed "mop-headed" (Fr. cheveux en tête de vadrouille).

The ultimate cause of these differences in general appearance and mode of growth lies in the shape of the individual hairs. In the straight type the shape is almost that of a cylinder and naturally hangs straight, like a piece of flexible rubber tubing hung by one end; in the woolly type the hairs are flat, and curl up like shavings. This difference is precisely obtained by measuring under a microscope the dimensions of cross sections of individual hairs, obtaining an average of many such measurements, and then expressing this in the form of a proportion, in which the length, or

longer diameter, is taken as 100, and the shorter diameter compared with it. This gives the following:—

$$\text{Hair Index} = \frac{\text{shorter diameter x 100}}{\text{longer diameter}}$$

In a perfectly cylindrical hair, the shorter diameter would be the same as the longer, and the index would be 100; but in a flat hair, with the shorter diameter but one-half that of the longer, the index would be 50, and so on. As a matter of fact, although individual hairs may be 100, that is, perfectly cylindrical, there is no race with an average index as high as 100; in the same way individual hairs of the woolly type may have as low an index as 40, that is, the breadth is but two-fifths that of the length. The calculated indices of several different races, representing the average from many individual measurements, are as follows:—

Table of Hair Indices (Shape of Cross Sections)

1 Armenian	92.63
1 Tamil (Ceylon)	91.88
2 Chinese	89.31
1 Japanese	87.34
1 Abyssinian	84.36
3 Alsatians[1]	81.93
4 Hindus	78.79
1 German (Baden)	76.70
7 Sudanese	71.47
3 Negroes (N. America, Guinea, etc.)	62.17
1 Solomon Islander	53.92
Japanese	85
Tibetans	80
Eskimos	77
Europeans	72.62
Negroes	60.50
Hottentots, Bushmen	50.40

[1] The average of the Alsatians is raised by the high index of one of them, 90.39; otherwise they are near the German from Baden, 75–79. Individual

In average length the hair with the highest index, i. e., the straightest, is the longest, from which it averages shorter and shorter to Class IV, the woolly type, which is the shortest. In the intermediate grades, Classes II and III, there is marked sexual difference in the length of the hair, that of the females being decidedly longer than that of the males; in the extremes, Classes I and IV, the hair is of about the same length in the two sexes. In the types with a sexual difference in the length, the males are more or less heavily bearded; in Classes I and IV, on the other hand, the beard is usually scanty and frequently quite wanting. Again, bearded races have more or less hair over the surface of the body, while in those with little or no beard the general skin surface is perfectly smooth, with no appreciable indication of hair. This marked difference is seen by comparing the body of a moderately hairy European with that of a Negro. Probably the race with the greatest amount of hair on the body is that of the Ainu, the aboriginal inhabitants of Japan and still living in the northernmost island of the original group, Yezo, although it is even here often no greater than in a very hairy European. In hairy races the hair of the body is longer and more abundant in the males than in the females, but that of the head is the reverse. In certain regions of the body, the hair is always more abundant, as the back of the forearms and the chest; in this latter point hairy men are at variance with the living apes, in which the region of the most profuse growth is along the back, while the chest is inclined to become hairless.

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hairs from the same head vary within broad limits. Frédéric found single hairs with an index of 100 even among the Sudanese, and those as low as 66 in a Chinese. It has also been pointed out by Martin that the same hair varies in shape, and consequently in index, along different portions of its shaft, and on that account is induced to reject the hair index altogether as a criterion of race. Still, the figures, if taken broadly, including a large number of individual measurements, seem to have some ethnological value, and the correlation between the shape of the individual hairs and the disposition of the hair as a whole is a definite one.

The thickness of the cranial hair has been ascertained in a few cases. This is done by counting the hairs upon a number of square centimeters of scalp surface and obtaining an average. By this means it has been ascertained that the Japanese have upon the scalp 256-286 hairs per square centimeter, and the Ainus but 214. This character has not been yet shown to have any definite ethnological significance, and is probably largely an individual character. Thus, in three Alsatians the number of hairs per square centimeter was respectively 260, 300, and 412, in each case from the parietal region. The thickest hair of several cases recently studied (Frédéric, 1906) was found in a Fellah, 580; an Italian boy, 468; a Sudanese, 448; and an Abyssinian, 440. The thinnest cases were those of two Sudanese, male and female, who each numbered 236; a Chinese with 224 and a Japanese with 258.

Grayness and baldness, those two retrogressive changes that are the bane of Europeans, seem not to be as frequent in other races. Thus baldness is ten times as frequent in whites as in negroes, and in the American Indians it is still more rare. The cause is found by some authorities in the frequent hair cutting demanded by civilization of all males, and the phenomenon is the result of a final exhaustion of the power of regeneration. Normally, they say, the hair reaches a given length, and there remains throughout life, the renewal being slight, and affecting single hairs. After the cutting process the body seeks to regenerate it, and this power suffices for a few times but is often inadequate to the repeated demands upon it. This theory is far from proven but receives some confirmation from the fact that it is mainly the males that are affected by baldness.

The racial distribution of grayness seems to follow that of baldness, with the exception that in a race inclined to this change both sexes are about equally affected. Grayness is often premature in the white race, but appears only as a sign of advanced age in others.

The color of the hair is usually correlated with that of the skin; that is, the more pigment there is in the one, the more appears in the other. Thus the dark-skinned races usually have dark, often intensely black, hair; in the light-

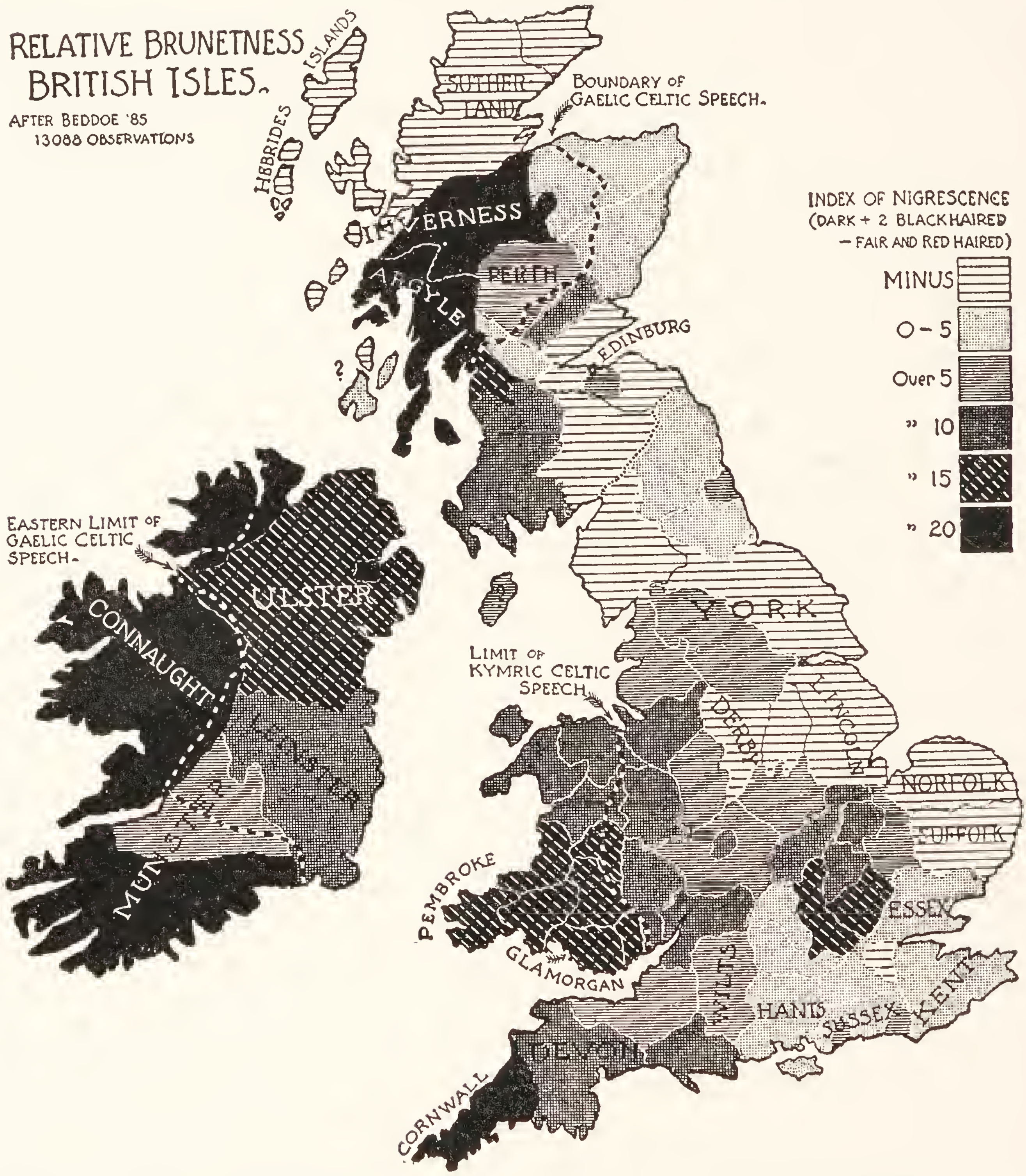

FIG. 101. Map showing the distribution of hair color in the British Isles. From Ripley, after Beddoe. (Cf. p. 301, above).

skinned races the hair exhibits the various shades of blond or brown. Albinism, or a total lack of pigmentation, is not an extreme case of blondness, but is an anomaly, and likely to appear in any race. When typical the skin and even

the iris of the eye are equally wanting in coloring matter, and the eyes appear pink. Red hair also seems in certain cases to be somewhat anomalous, and may appear in a dark-skinned, or even a black, race. When it occurs among Europeans it is more normal and seems to form a grade between yellow and brown.

For purposes of ethnological description the various hair colors may be arranged in the following categories, placed in two main groups:—

Blond	flaxen	Brunet	light brown
	golden yellow		dark brown
	sandy		black (of white race)
	chestnut		black (dull, jet or sooty)

A sample set of hair colors (Haarfarbentafel) representing 30 different shades, has been constructed by Fischer and is obtainable through Hermann of Zürich. The samples used are tufts of silk of the required colors, and the whole is fastened into a frame bearing the numbers. The entire apparatus is securely held in a nickel case, which is light-tight to prevent fading.

A further character of hair, of great ethnological importance, is the relative amount on the body, the amount of *pilosity*. As would be expected, primitive man was undoubtedly very pilous, and the surface of the body was probably covered with short hair. On the other hand certain of the highly specialized races, for instance the negroes, show no hair on the body and but scanty suggestions of a beard. The primitive peoples of the present, like the native Australians, or the Veddahs of Ceylon, exhibit a profuse growth of body hair, and in one of the highly specialized races, the Caucasian, this profuse hairiness is retained. The hairiness of the limbs is frequently seen on bathing beaches, and during athletic sports, but the full-beardedness in men of European origin is concealed at present by the universal fashion of repeated close shaving, and it is only in such unusual circumstances as shipwreck, exploration,

or the exigencies of illness or war, preventing recourse to the razor, that we can really appreciate the type of people among whom we live.

Normally among races that are profusely pilous the cultivation of a beard is universal, and the beard itself is the center of various ideas and beliefs connected with it. "By the beard of the prophet" is felt to be an especially strong oath, and to seize one by the beard is an insult to be wiped out by blood alone. Among races that have but a scant beard, on the contrary, the dictates of fashion demand its removal, even by the drastic treatment of pulling it out by the roots. Many an Indian brave spends much time with the clam-shells, which serve as tweezers, while his Arab brother wastes a like amount on unguents calculated to insure a luxurious growth.

80. The Stature. The bodily height, or *stature*, while not definitely correlated with any climate or skin color, is yet remarkably constant in a given tribe or race, when the average of a large number of individuals is taken. It is here noteworthy that the popular estimate of the stature of extremely short or extremely tall races is much exaggerated, and that the early explorers, or vanguards of a migrating tribe, bring back magnified ideas that later scientific measurements do not justify. The Jotuns and Trolls of the Norse legends, the giants and dwarfs respectively, seem now to have been merely the Finns and the Lapps, the one taller than the average Norwegian, the other shorter.

The Children of Israel, entering a land with the avowed purpose of driving out the inhabitants, found themselves "as grasshoppers" in the sight of those whom they were later to dispossess, and the early tales of the gigantic Patagonians still survive, in spite of recent scientific measurements, which show these latter to be tall men, though not extremely so. Similarly, the Akka pigmies of Equatorial Africa average only 87 millimeters less than the Aëtas of the

Philippines, or 150 millimeters less than the Bushmen or the Scandinavian Lapps. The extremes of racial averages thus far obtained are those of the Akka pigmies, at 1378 mm., and the Argyleshire Scots, at 1792 mm.

In obtaining the racial average a large number of individuals should be taken, preferably separate figures for men and women, and there should be no conscious selection of individuals, either of extreme or of medium specimens. Individuals recognized by other features as true giants or dwarfs, that is, pathological cases, should be excluded, as would all other abnormalities, but it will be noticed that among perfectly normal individuals there will be a few that vary considerably from the average, either above or below. All measurements are taken with the subject standing erect, but in a natural position, and, of course, without shoes.

For purposes of classification statures are somewhat arbitrarily divided (males only) as follows:—

Below 1550 mm.	very small
1550–1600	small
1600–1650	below the medium
1650	medium
1650–1700	above the medium
1700–1750	large
Above 1750	very large

The following list gives the average stature of some of the most important human races, grouped as above:—

I. Very Small (below 1550)

Akka pigmies	1378
Bambute pigmies	1452
Aëta (Philippines)	1480
Andaman Islanders	1485
Bushmen (Kalahari desert)	1529
Lapps (Scandinavia)	1529
Ostiaks from the Yenesei	1540

II. Small (1550–1600)

Veddahs (Ceylon)	1554
Caribs (Venezuela and Guiana)	1572
Eskimos (Labrador)	1575
Japanese (1200 soldiers)	1585
Timorese (East Indies)	1597

III. Below Medium (1600–1650)

Siamese	1607
South Chinese (Kwang-Si)	1615
Eskimos (Greenland)	1621
German-Swiss conscripts	1629
Moki Pueblos	1629
Australians (New South Wales)	1630
Papuans	1640
Bateke negroes (Congo)	1641
Russian conscripts (European)	1642
Italians	1645
French	1646

IV. Above Medium (1650–1700)

Greeks	1651
Turks	1660
Australians in general	1667
Prussian conscripts (Thuringians)	1667
North Chinese (Chi-Fu)	1674
Inhabitants of Holstein	1677
Cherokees	1677
Swedes	1681
Negroes of the United States	1682
Dutch conscripts	1685
Navajoes and Apaches	1686

V. Large (1700–1750)

French-Canadian soldiers	1703
Swedish soldiers	1705
Sikhs (Punjaub; India)	1709
English	1712
Pawnees	1713
Kaffirs	1715

Inhabitants of the United States	1719
Irish	1725
Sioux	1726
Samoans	1726
Negroes from the Sudan	1730–40
Cheyennes	1745
Scotch (in general)	1746
VI. Very Large (above 1750)	
Scotch (Ayrshire, etc.)	1782
Scotch (Galloway; Argyleshire)	1792

81. The Proportions of the Living Body. The study of the proportions of the body early occupied the attention of men in the application to various attempts to represent him. Some of the earliest known Egyptian statues, carved out of wood, were extremely lifelike, and correct in their proportions, but there soon developed a conventionalized human figure which set the standard for all Egyptian artists, and further progress stopped. The Greeks, however, never developed in this conventional direction, and the proportions of the human figure developed in the days of Phidias and Praxiteles to an extent never since surpassed or even equaled. It appears that the sculptors of that time relied extensively upon a definite formulation of proportion, the canon of Polycletus, which is thought to be embodied in the statue of the Doryphorus (Spear-carrier), of which there is a copy in the Museum at Naples.

According to this canon the face is $^1/_{10}$ of the total height, the entire head is $\frac{1}{8}$, the head + the neck $\frac{1}{6}$, and so on. The face is in three equal parts; chin to lower border of nose, thence to its upper limit, and from here to the roots of the hair. So accurately did the Greek sculptors represent the people of Southern Europe, that they could be used for anthropometrical measurements as with the living, and some have asserted that the famous Apollo Belvidere, the proportions of which are negroid rather than European, was produced from a negro model.

Numerous recent attempts to formulate rules of human proportions, and especially those applicable to the various races, have been made, especially since the rise of Physical Anthropology. Thus we have the canons of Hay and Fritsch, and the outline drawings of Schadow and Merkel. These studies are mainly confined, however, to the proportions of members of the European or white race, and little has been done in the same direction for other races.[1]

Recently a second object for the study of bodily proportions has been furnished by the spread of gymnastic training among the students at American Colleges, and at the present time a comprehensive series of measurements of each student is taken, for the primary purpose of obtaining data concerning the efficiency of the system, and in order to direct the training in the individual cases. The data thus obtained have been made some use of for other purposes, notably by Sargent, but these also, like the researches of the artists, are thus far limited to members of the European race, and in addition concern only the years of adolescence, and thus hardly give the proportions of complete maturity. A certain

[1] The Canon of Polycletus is known to us in part by the references to it made by Vitruvius, Galen, and Pliny; and in part from the tradition that it is embodied in the statue of the spear-thrower (Doryphorus), now in the museum at Naples (perhaps an ancient copy of the original). Michaelis held that Polycletus obtained his rules from the averages obtained from the measurements of well-formed youths.

For the subject of this and other canons of human proportions, cf. Zeising; Neue Lehre von den Proportionen des menschlichen Körpers, 1854.

Quetelet; Des proportions du corps humain. Bull. de l'Acad. royal des Sciences, Lettres, et Beaux Arts de Belgique. (This author forms a series of average proportions upon the measurements of thirty young men.)

Schadow; "Polyklet," oder von den Massen des Menschen nach dem Geschlecht und Alter, 1834.

Fritsch-Harless; Die Gestalt des Menschen, München, 1899.

Richer; Canon des proportions du corps humain, 1893.

For Sargent's work, cf. Scribner's Mag., Vol. XIV, 1893, p. 130.

Merkel; Normal-gestalt, in "Handbuch der topographischen Anatomie, 1896.

Geyer; Der Mensch; Hand- und Lehrbuch. Union Deutsch. Verlags-gesellsch., 1902.

amount of this sort of study is now extending itself to the secondary schools, and the data thus obtained have been found of much use by the anthropologist, especially the statistics of hair and eye color.

Somewhat similar in methods and object are the quite extensive physical data collected from recruits for the armies of the various countries, especially Germany, and these also furnish valuable information to the anthropologist.

The great value of the above data in the study of anthropology suggests the direct collection of them in the interest of this science, particularly in their relation to ethnology, one important goal of which is to examine critically all the physical characteristics of all the peoples of the globe, and from the facts thus obtained to separate them into their natural groups, and speculate concerning the origin, past history, and relationships of each. Such statistics are naturally difficult to obtain, and in the case of the more primitive races, who are always suspicious of such proceedings, the object of which they cannot understand, the work is often dangerous to the investigator, or even impossible to accomplish. Still, however, much has been done already, although far more remains to be accomplished.

To render such statistics available for comparison the investigation of a tribe or race should rest upon a large number of normal individuals; they should then be reduced to averages, and for many purposes these should be expressed by indices. A certain measurement is taken as a standard, or *modulus*, with the proportional value of 100, and the other measures are compared with it, the results expressed in decimals. Thus Topinard (1891), using as the modulus the total stature, gives the following normal proportions for Europeans:—

Total stature	100.0
Arm stretch	104.4
Head (height of)	13.0
Trunk, with neck	35.0

Trunk, without neck	32.7
Upper limb (entire)	45.0
Upper arm	19.5
Forearm	14.0
Hand	11.5
Lower limb (from plane of ischium to the ground)	47.5
Foot	15.0

Another modulus, in some respects more practical, is that of the *trunk-length.* For this the sitting height may be used, the position taken by the subject being that sitting upon a table with the feet raised on a chair, thus flexing the knees enough to prevent the possibility of raising the body through the action of the thigh muscles. The plane of the table is the same as that of the ischia, and the trunk-length may be either that of the entire sitting height from the top of the head to the table, or that of the trunk without the head and neck by measuring the height from the table of the incisura sterni (called anthropometrically the *suprasternale*) or that of the projecting point of the seventh cervical vertebra (anthropometrically *vertebrale*).[1]

[1] Some recent literature on the subject of bodily measurements are the following:—

Koganei, J.; Kurze Mitteilungen über Untersuchungen von Ainoskeletten. Archiv. für Anthropologie, Bd. XXII, 1894, pp. 371–392.

Koganei, Y.; Ueber die Urbewohner von Japan. Mitteil. der Deutsch. Gesell. für Natur- und Volkerkunde Ostasiens, Bd. IX, Tokio, 1903, pp. 297–329.

Jochelson-Brodsky (Mme. Dina); Zur Topographie des weiblichen Körpers nordostsiberischer Völker. Archiv. f. Anthropol., 1906, pp. 1–58.

Teumin, Sara; Topographisch-anthropometrische Untersuchungen über die Proportionsverhältnisse des weiblichen Körpers. Archiv. für Anthropologie, Bd. XXVII, 1902, pp. 379–432.

Rodes, C. B. Jr.; The Thoracic Index in the Negro. Zeitsch. Morphol. Anthropol., Bd. IX, 1905, pp. 103–117.

Johnson, Marjorie; A study in surface anatomy with special reference to the position of the umbilicus. Anat. Record, Vol. 5, No. 10, Oct., 1911, pp. 461–470.

Boas, F.; A. J. Stone's measurements of Natives of the Northwest Territories. Bull. Amer. Mus. Nat. Hist., New York, Vol. XVI, 1901.

Wilder and Pfeiffer; The bodily proportions of women in the United States, based upon measurements taken from one hundred Smith College students. Proc. Amer. Acad., No. 16, Nov., 1924.

82. Other Bodily Characteristics with Racial Significance. Certain marked external bodily characters, like the steatopygy of the bushwomen, or the *tablier* of the women of the Hottentots, have long been observed, and, owing probably to their conspicuousness, have counted as racial characters. More scientific observation has somewhat detracted from these characters as definitely racial, either inclusive, including all members of a given race, or exclusive, not to be found elsewhere. While cases of occurrence of these peculiarities are very conspicuous, and certainly are calculated to attract the attention of the curious traveler, they are liable to be of minor importance to the ethnologist.

On the other hand, internal variations, brought out by dissection, are numerous and found to be very frequent. As with other characters, their sporadic occurrence is of no racial significance, but the proportionate occurrence, as shown by repeated dissections in dissecting rooms, is of real ethnological significance, and a large percentage of occurrence of a certain muscular anomaly can be used, equally with a certain type of hair, or a certain form of nose, in framing a satisfactory racial definition.

This is well brought out by the spread of Medical schools, especially over parts of the world where we have formerly had no information concerning the detailed anatomy of the inhabitants, and where the subjects have been supplied locally. Negro bodies have long been used in the United States, and a great gain in racial anatomy has occurred since the introduction of the Chinese and Japanese into modern medicine, with their own dissecting rooms, yet there is much in this direction still to be established.

Mention may here be made, by way of example, of the integumental muscle, the *Sternalis*, known only as a rare anomaly among Europeans, but with a large percentage of occurrence among Japanese. The muscular system of the negro has been recently made the subject of extensive investigation, and has been found to differ in numerous

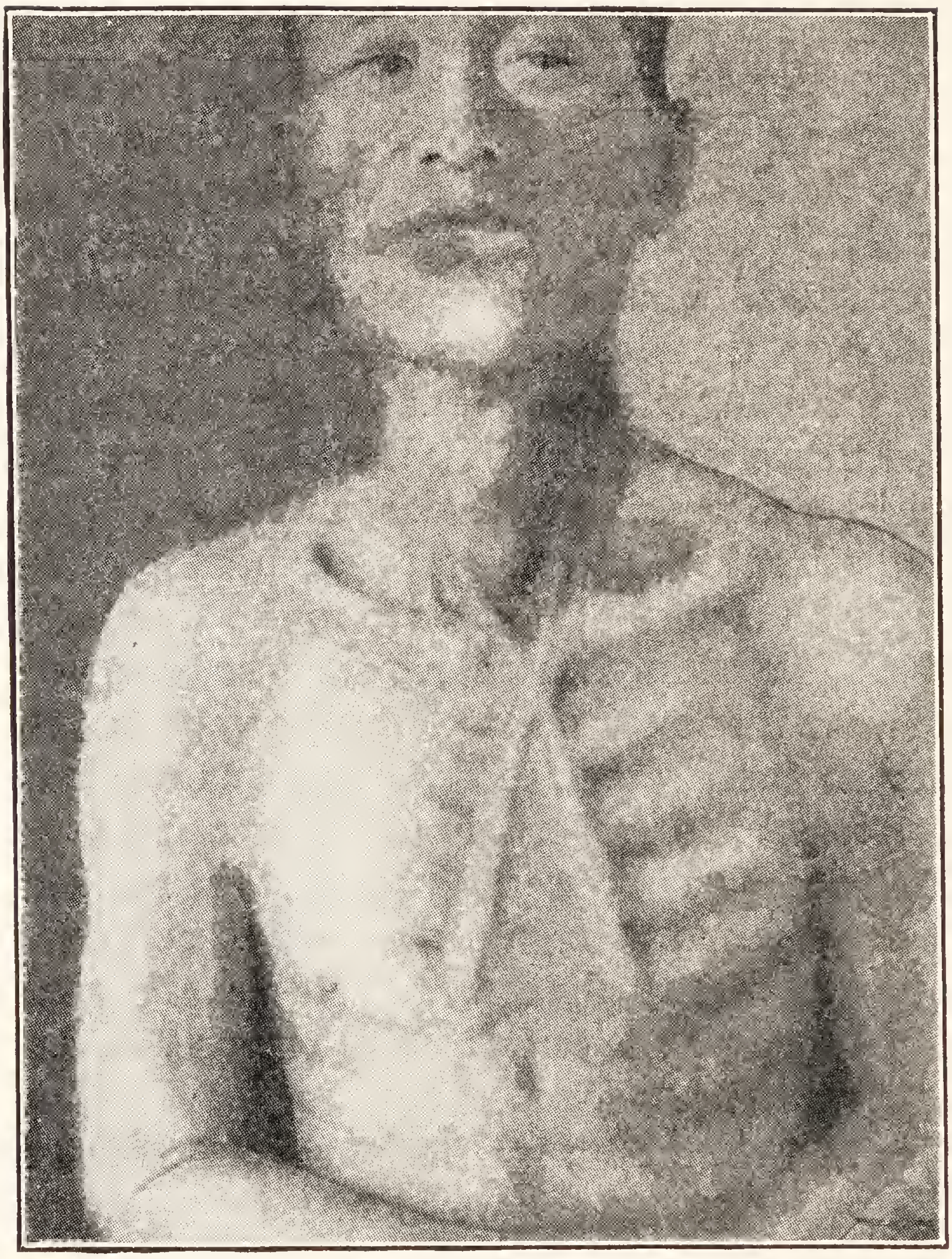

FIG. 102. Sternalis muscle in a living Japanese. After Adachi

details from the conventional form laid down in European text-books and based on the study of European bodies. Similar differences, which may be considered racial in their proportion of occurrence, have also been noted in such detailed parts as the lacrimal gland, the papillae of the tongue, the mammae, and the ridge-patterns (friction-ridges) of the palms and soles.[1]

[1] Adachi, B.; Das Knorpelstück in der Plica semilunaris conjunctivae der Japaner. Zeitschr. Morphol. u. Anthropol., Bd. IX, 1906, pp. 325–326.

Loth, E.; Beiträge zur Anthropologie der Negerweichteile (Muskelsystem). Stuttgart, 1912, pp. 1–245.

Hopf und Edzard; Beobachtungen über die Verteilung der Zungenpapillen

Aside from such definite inheritable characteristics, the members of many races are characterized by certain cultural modifications, the result of either intentional mutilation, the restricting action of some mode of dress, or of an habitual attitude of posture. These, although artificially induced, are often of value in diagnosing a given race, and in cases in which the modification is deep enough to affect the bones or teeth, they may be of great assistance in studying excavated human remains. Curiously enough, one of the chief reasons for intentional mutilation is for the purpose of distinguishing the members of a given tribe; as instances of which may be mentioned the circumcision of the Jews, and others, various forms of tattoo, serving as "tribal marks." Of this latter character was evidently the famous mark put upon Cain in the Hebrew legend, not that he might be known everywhere as a murderer, but that he might be taken for a member of the tribe to which he was banished, and not be killed at sight as an alien. Other cultural malformations are for the purpose of giving a formidable or savage appearance, as the filing of the teeth, or the gashing of the body in such a way as to produce raised scars, as seen among many of the Bantu tribes of South Africa, the

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bei verschiedenen Menschenrassen. Zeitschr. Morphol. und Anthropol., XII, 1910, pp. 543–558.

Bloch, A.; Essai sur les levres au point de vue anthropologique. Bull. soc. d'anthropol., Paris, Ser. 4, t. IX, 1893, pp. 284–301.

Hörschelmann, E.; Ueber die Form der Mamma bei den Esten. Zeitschr. Morphol. u. Anthropol., Bd. VII, 1904, pp. 22–62.

Wilder, H. H.; Racial differences in palm and sole configuration. I. (On Negroes, Mayas, and Anglo-Americans). Amer. Anthropol., Vol. VI, 1904, pp. 244–293.

II. (On Liberian natives; prints collected by Fr. Starr). Amer. Anthropol., Vol. XV, 1913, pp. 189–207.

III. (On Chinese and Japanese). Amer. Journ. Phys. Anthropol., Vol. V, No. 2, Apr.-June, 1922.

Loth, E.; Anthropologische Untersuchungen über das Hautleistensystem der Polen. Zeitschr. Morphol. u. Anthropol., Bd. XIII, 1910, pp. 77–96.

Schlaginhaufen, O.; Zur Morphologie der Palma und Planta der Vorderinder und Ceyloner. Zeitschr. für Ethnologie, 1906.

Australian natives, and among the students in the German universities.

Each of the two common human positions when resting, either squatting upon the ground or sitting upon a raised object, produces its own effect upon the bones of the leg, especially of the ankle joint, and may thus be used as a racial diagnostic in the case of an excavated skeleton, when, as in America, the diagnosis is often to be made between an aboriginal race that squats and a usurping cultured race that sits. In the former attitude all of the leg joints are capable of being more violently flexed than in the latter, and correspondingly the articular surfaces involved are more extensive in the races that habitually squat. This is especially well shown in the contact surfaces of tibia and astragalus, which are especially involved in this action.

Of late the idea has obtained some credence that the peculiar habitual attitude of the Japanese, a form of squatting, has shortened the bones of the leg, especially that of the tibia, and that the introduction of chairs may have the effect of increasing the average stature of the nation. Presumably to this end Japanese school children are now being seated at desks, as in other civilized countries.

CHAPTER VI.

CLASSIFICATION OF HUMAN RACES

83. Early Attempts to Classify Human Races. In my very first school I learned that man was divided into five races by their color, White, Black, Yellow, Red, and Brown, of which the typical representatives would be the Europeans, the Negroes, the Chinese, the American Indians, and the Malays, and as I received this instruction with the finality of early childhood it seemed for a long time a simple and satisfactory answer to a difficult subject. Much later I learned that this idea, widespread in all the elementary text-books, was the invention of a great German anatomist of the 18th century, Johann Friedrich Blumenbach, and I now feel that it was rather fundamental. Using the more technical terms as Blumenbach used them, *Caucasian, Ethiopian,* and *Mongolian,* instead of the simple colors, for the first three, we have certain easily comprehended terms which, if not in every way satisfactory, are at least adequate for technical terms, and, when once defined, will serve better than many another word to define these three definite races. The two last are perhaps better dropped.

Earlier than Blumenbach comes the *Systema Naturae* of Linnaeus, a classification of all the animals in the world, as then known, and destined, as are all such catalogs, to increase indefinitely. Here, at the very first, Linnaeus places Man, and enumerates four distinct human races or varieties, with a brief characterization of each. As a distinct advance upon previous work, and showing a very liberal spirit, quite unusual at the time, Man appears as an animal form with Genus and Species, *Homo sapiens.* There were, as might have been expected at the time, the usual number of prodigies recorded, such as *Homo sapiens ferus,* with the description "tetrapus, mutus, hirsutus," and the variety monstrosus,

which found room for various kinds of monsters, but, together with these, there were recorded four fundamental human races or varieties, designated by Greek letters, Α, *Americanus;* Β, *Europaeus;* Γ, *Asiaticus;* Δ, *Afer,* plainly the originals, or at least the continuation, of ideas then generally held, and directly continued into the five races of Blumenbach.

The appended descriptions were partly physical characters, but partly also psychical, moral, and ethnographical, and decidedly under the rule of natural prejudice, clearly indicating the author as one of the European race himself. Thus for the variety *Europaeus,* Linnaeus gives:

Europaeus albus, sanguineus, torosus.
Pilis flavescentibus, prolixis. *Oculis* caeruleis.
Levis, argutus, inventor.
Tegitur Vestimentis arctis.
Regitur Ritibus.

In contrast to this compare the variety *Asiaticus,* suggestive of the "half-civilized" of another geographical classification.

Asiaticus luridus, melancholicus, rigidus.
Pilis nigricantibus. *Oculis* fuscis.
Severus, fatuosus, avarus.
Tegitur indumentis laxis.
Regitur Opinionibus.

In the same way he characterizes the variety *Afer* as "Regitur Arbitrio" and the variety *Americanus* (the Indian, of course) as "Regitur Consuetudine." In dress this latter variety "Pingit se lineis daedaleis rubris," while variety *Afer* "Ungit se pingui." This same poor African "Regitur Arbitrio" and is in character "vafer, segnis, negligens," a rather unenviable characterization.

This extension of racial characters to include mental and moral qualities has been employed in modern times by Keane, to whom the Mongolians are said to be

> "dull, reserved, somewhat sullen and apathetic; but in some groups active and energetic; nearly all brave, warlike, even fierce, and capable of great atrocities, though not normally cruel."

The American aborigines are characterized as

> "moody, reserved, and wary; outwardly impassive and capable of enduring extreme physical pain; considerate towards each other, kind and gentle towards their women and children, but not in a demonstrative manner; keen sense of justice, hence easily offended, but also easily pacified. The outward show of dignity and a lofty air assumed by many seems due more to vanity or ostentation than a feeling of true pride. Mental capacity considerable, much higher than the Negro, but on the whole inferior to the Mongol."

In temperament the Caucasic Peoples are:

> "1. (North European or Teutonic) earnest, energetic, and enterprising, steadfast, solid, and stolid; outwardly reserved, thoughtful, and deeply religious; humane, firm, but not wantonly cruel. 2 and 3. (H. alpinus and H. mediterranensis) brilliant, quick-witted, excitable, and impulsive; sociable and courteous, but fickle, untrustworthy, and even treacherous; often atrociously cruel; aesthetic sense highly, ethic slightly developed. All brave, imaginative, musical, and richly endowed intellectually."

Upon reading the above characterizations, which are in the main correct in all probability, we begin to doubt whether such mental and moral peculiarities should be included among racial characters, and whether any of us are sufficiently broad and unprejudiced to hazard such a statement, which, at the present state of our knowledge of psychology, are at best opinions. If we confine our characterizations of races to physical characters, we are dealing with indisputable facts, and keep well within the bounds imposed by the measuring tape and the anthropometer, where the characters used are beyond the reach of opinions and can be easily verified. Still it is a matter of great interest to read Keane's characterizations, and he certainly intends to be perfectly just. It is, however, safer to confine oneself to physical characters, as is done here, and as a zoölogist from

the planet Mars would do, if the individuals were brought him in alcohol.

84. A PROPOSAL FOR A NEW CLASSIFICATION. At the base of any group of animals we find a generalized or synthetic form. This has all the characters of the group, yet not well adapted to a definite end, not specialized. In many of these cases, since the rise of paleontology, these generalized animals are fossils, and may be the actual ancestors of later animals living today; in other cases they are more or less like the real ancestors, and owe this retention of early characters to the absence of those conditions which stimulated modifications.

Having once determined upon the form of the generalized ancestor the rest may be treated as descendants along various paths of specialization from this synthetic ancestor, and the interrelationships of the entire group may be placed in the form of a phylogenetic tree.

In the same way in a classification of the different human races there may be easily separated three highly specialized races, with definitely differentiating characters, which form numerically the bulk of humanity, while there are many others, less distinct, which may be related to the former as showing the beginning of such specializations. Lastly there is at least one very generalized group of humanity that represent the undifferentiated, generalized stock, from which all the others may be considered as having been derived.

The three highly differentiated human races are in order the White, the Yellow, and the Black, or more technically, the Caucasian, the Mongolian and the Ethiopian, names which have only an historic meaning, but which are convenient by which to name and distinguish them. Then come series of less differentiated races with some affinity to these three highly specialized ones, and which may be collected under the general terms, Proto-Caucasians, Proto-Mongolians and Proto-Ethiopians. Among the first may be

found the Polynesians, the Ainus, and the Dravidians of the peninsula of India. As Proto-Mongolians there may be reckoned the aboriginal inhabitants of the large East Indian islands, like the Dyaks and the Igorotes, and perhaps also the Malays; as for the Proto-Ethiopians there are the Papuans, the Melanesians and the Bushmen of South Africa.

Lastly, after removing not only the three highly specialized, or *metamorphic*, races, together with all the ancestral forms related to them, and designated as the "Proto" peoples (the *Archimorphs*), there is left the most generalized race of all, the Australian blacks. These, designated as *Protomorphs*, are the most generalized of all people on the earth at present, profusely hairy but with neither the wool of the Ethiopians, nor the straight hair of the Mongolians, with broad noses, though not particularly flat ones, and with the heavy brow-ridges that strongly remind us of the Neandertal man. The Veddahs of Ceylon are also very primitive and some would have it that the vast race found in the Western Hemisphere by the European discoverers, and called by us through an error the "Indians" are also Protomorphs, although it seems better to consider them a fourth main branch related to the Mongolians.

Viewing the human races in this way, as the product of an evolutionary process, their interrelationships seem to be represented by a branching tree, with dividing branches, rather than as a series of categories of equal rank, as was formerly sought. We turn our attention at first to the least specialized people, who represent still the original, primitive stock from which the more specialized later stocks may be considered as having arisen, and then from them follow the different lines of development to the ends of the branches, where the terminal branches diverge to the extreme of specialization. In such a conception, there will be found some modern races that are placed along the lines, not all at the termini of the branches, very useful in tracing the roads along which the termini have passed during development.

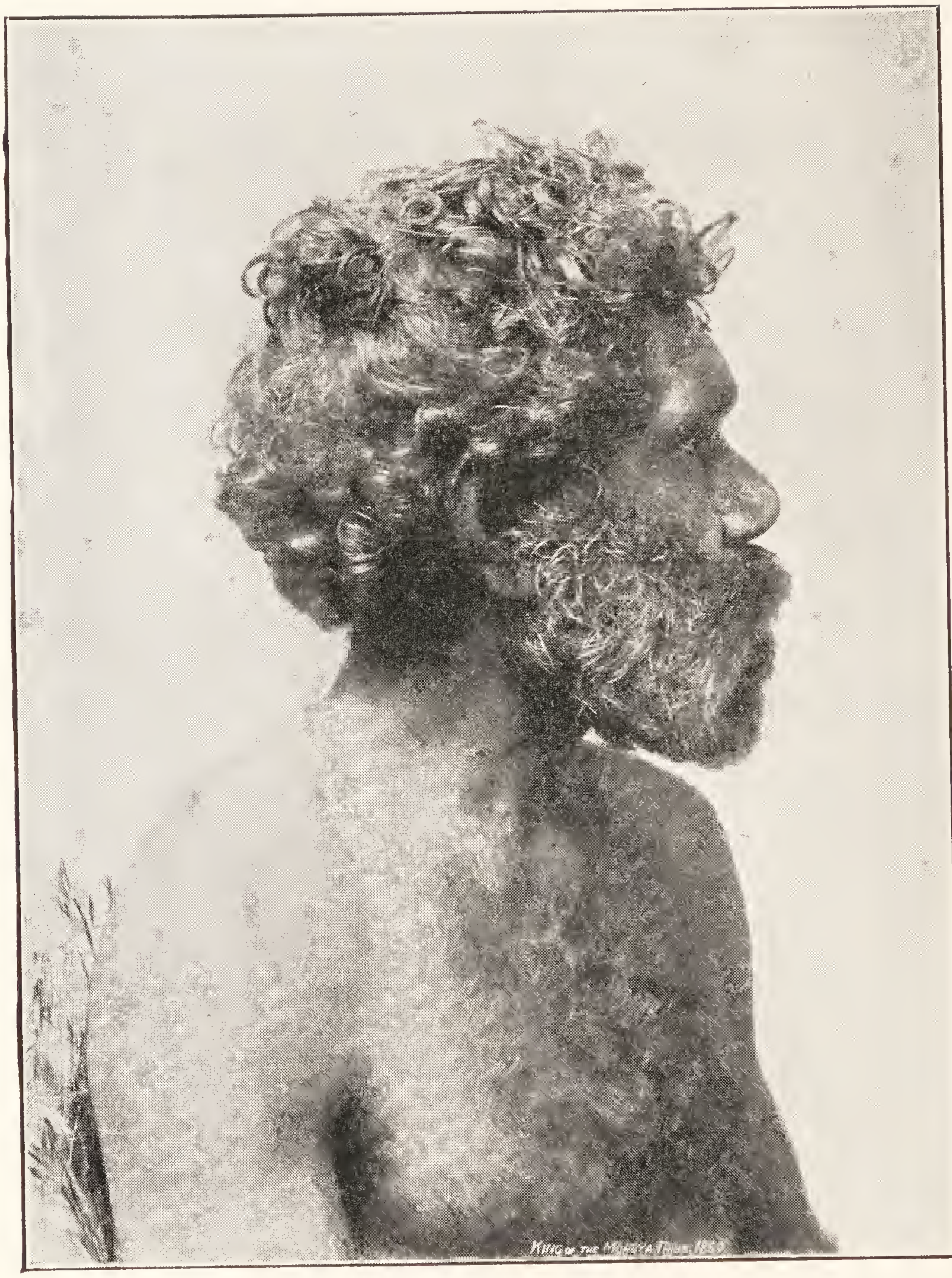


FIG. 103. Native Australian; the king of the Moruya Tribe. This man shows a high degree of pilosity, yet no greater than that frequently met with among the most cultured Europeans, where the artificial removal of the hair of the face and the concealment of the rest by the clothing mask the real condition.

Photographed by Kerry and Co., Sidney, N. S. W. By permission.

85. The Protomorphs. Probably the majority of the ethnologists would select the native Australians as the most generalized race in the present day world, that is, the most comprehensive, generalized type. In them we find neither the Mongolian type of eye, nor the spiral rolled hairs, the "wool," of the Negro. They are entirely lacking in the special characters that differentiate the metamorphic races. Their characters are those of the generalized human being, *Homo sapiens* unspecialized. Among Australians one may find suggestions of every detail which, when thoroughly differentiated, are characteristic of the members of the three highly specialized races. There are suggestions of the thick lips of the Ethiopian, the hairy bodies found among the Caucasian, and the hair, intermediate between the straight black hair of the Mongolian and the thick frizzly mat of the Ethiopian, give us the sources from which the specializations of later times have been derived. That is, it would be quite impossible to classify an Australian with any of the three specialized races, but it would be quite possible to see how, by emphasizing now one and now another character, these races have all arisen from this one primitive stock.

Geographically the location for this primitive, undifferentiated, human stock in Australia where the large carnivores have never developed, corresponds well with an ingenious modern theory (Schoetensack's) which fixes Australia as the center of dispersion of the human race, as in the rest of the world early man would have had to compete with antagonists too fierce for it before it had developed weapons of any sort. It is also to be remembered that the Papuans, but little more differentiated than the Australians, are very near them geographically, and ethnologists of the present day have hardly forgotten the former inhabitants of Tasmania, adjacent on the south, a race probably a bit more primitive than the Australians. In fact all the peoples that have served as the original stock from which men originated, Polynesians, Dravidians, Veddahs, and what not,

with the exception of the American Indians, doubtfully protomorphic at best, are located in this part of the world. The Australians have already been shown to possess characteristics, mainly characters of the skull, which are strongly reminiscent of the species *neandertalensis*, and ethnologists have not been lacking who are ready to assert that this latter species may not have been exterminated but that it contributed its blood to the development of the present species *sapiens*. If, now, we start with the Australians, and define the salient characters of each of the three most highly differentiated modern races, using their most characteristic features as parts of the definition, we shall find that we have three definite points upon which we may base our classification, without touching upon the dangerous ground of the degree of civilization, or the mental powers, or moral tendencies, or, least of all, our prejudices. The scientist from Mars, to whom has been shipped representatives of all races preserved in alcohol, but not too carefully labeled, will be our best guide.

86. THE METAMORPHIC RACE OF LEUCODERMS: THE "CAUCASIAN" RACE. In no way has human prejudice worked to greater disadvantage than in the treatment of this particular race. In the headquarters of Western learning we have long been taught to feel that all the great achievements of the human race have been done by Caucasians, and that the Caucasians are the highest and most highly specialized of all. Owing to the sad political relationships to the other races, particularly the Ethiopians in this (North American) continent, by which members of this last were held for a long time in disgraceful bondage by members of the Caucasian race, there has grown up a so-called "color line" to the disadvantage of the one that was wronged, so that a fair study of either race is not to be expected. The scientist from Mars with his alcoholic specimens would tell us that the Caucasian was the most generalized, still the

nearest to the Protomorph, and that the Ethiopian, with his conspicuous characteristics, was the most specialized, that is, the furthest removed from the original stock. This assertion is made clear by a summary of the specific characters of the Caucasian race, as follows:—

Skin color. Varies from a white, pigmentless skin, through the different shades of brown, to a jet black (Abyssinians, Tuareg.)

Pilosity. Hairy, often profusely so. Full beards in the male, frequently with legs and arms covered with hair.

Hair of head. Long, or very long, especially in the female, generally wavy or curly, seldom absolutely straight. In color the various shades of brown, when black not jet black, but showing some color. In certain northern peoples the hair is light blond, sometimes red as a variant of this. Index of cross section, 62–72.

Eyes. Moderately large and full, not showing the "Mongolian" fold, or the epicanthus. In color ranging through blue, hazel, with a touch of green, light brown to black.

Head shape. Two types: (1) dolichocephalic, index 74–79; (2) brachycephalic, index 80–85.

Nose. Leptorrhine, index on skull 44–46, on living 63–70, prominent and thin, nostrils long and narrow, axes antero-posterior.

Mouth. Lips thin, often everted, especially the lower lip, but not thick.

Distribution. Europe, northern Africa (north of the Sahara), western Asia, lately settled on the Western Continent, where it has blended with the native Indian stock, and with the Negroes, brought over from Africa as slaves.

87. The Metamorphic Race of Xanthoderms: the "Mongolian" Race. The Mongolian Race has had the longest period of being civilized of any race on the globe. When the British, with their bodies painted with woad, were dwelling in wattled huts, decorated with the heads of their enemies, the Mongolians were clothed in silks and

possessed of the refinements of culture. Of course the Martian scientist could know nothing of this, but, having described the Caucasian as above, he would write out the following description of the Xanthoderm, the typical Mongolian:—

Skin color. Presents almost as wide a range as is exhibited by the Caucasians, from white to very dark brown, with usually a definite and pronounced yellow cast.

Pilosity. Not noticeable, scanty beard in older men, and sometimes thin mustaches.

Hair of head. Long and very straight, shape of the individual hair nearly cylindrical, hair index 80–85, intensely black in color, in age becoming gray or bald, though perhaps not so much as in the Caucasians.

Eyes. Typical Mongolian eyes, with a rolling of the upper lid over the free edge, and usually with an epicanthus. Color of eyes dark brown, or even black.

Head shape. Brachycephalic, index 80–84.

Nose. Mesorrhine, index on skull 49–52, on living 75–83, nostrils oval or round.

Mouth. Lips full and often everted, but not thick.

Distribution. Eastern Asia, from the Arctic to the tropics. Probably the American Indians, and the Eskimos also, were originally derived from Mongolian stock, the Eskimos from northern Siberian tribes. Some ethnologists prefer to consider the Indians an early offshoot from Mongolian stock, when it was not specialized as such, and that they were then Protomorphic. At least twice during the early Middle Ages Mongolian peoples, in the role of conquerors, devastated Europe, and certain originally Asiatic people, the Finns, Lapps, and Magyars (Hungarians), have stayed in Europe. Certain primitive people of the East Indies are undoubtedly the original stock from which the Malays have been derived.

88. The Metamorphic Race of Melanoderms: the "Ethiopian" Race. This race shows the greatest amount of specialization on the globe, the most perfect adaptation

to the sun, and tropical heat. The dark skin color, the matted black hair on the head, and the smooth, hairless skin, are among the most striking characters, and the most specialized of adaptations to a tropical environment. In the hairless condition of the skin the Melanoderms are the furthest removed from the Protomorphs. The distinctive characteristics are the following:—

Skin color. Varies from light brown, "color of old leather," through a reddish brown to a sooty black. The palms and soles remain pinkish or yellowish.

Pilosity. Skin of the body generally smooth and satiny without trace of hair.

Hair of head. Head covered with tightly curled tufts, which usually forms in the adult a thick mat. In age it may become either gray or entirely lost, as in other races. Beard scanty, not connecting with the hair of the head.

Eyes. Large and full, sclera yellow, although in contrast with the black skin it gives the general impression that it is intensely white. Eye color black, often not showing the difference between iris and pupil.

Head shape. Dolichocephalic, index 71–77.

Nose. Platyrrhine or hyperplatyrrhine, index on skull 53–64, on living 100–120.

Mouth. Lips thick, both much everted, often protruding.

Distribution. The southern part of the continent of Africa. The Melanoderm Race has developed several moderately high civilizations, especially on the west of the Sahara, but never seemed to have crossed to the north of it. Northern Africa, north of the Sahara, has always been occupied by Caucasians.

89. THE ARCHIMORPHIC RACES: THE PROTO-CAUCASIANS. Isolated peoples, with evident affinities to the Caucasians, are found scattered over the warmer parts of Asia, and the Oceanic Islands; these may be grouped as the Proto-Caucasians. It is at least a convenient grouping, and collects together peoples that possess the same characteristics which discriminate the Caucasian main stem from the two

others, and indicates, without definitely asserting, a near kinship of all. All are more hairy over their bodies than any people except the Australians, which are Protomorphs; all have wavy hair; the men have full beards; the noses are

Fig. 104. A Tamil man. He is of the Dravidian race. This and the following seven photographs were taken in Jaffna, Ceylon, by S. K. Lawton, himself a full-blooded native Tamil, self-educated as a photographer.

thin and prominent, and in general the color of their bodies is not especially dark. Perhaps the most extensive strain are the Dravidians, the race populating the southern half of the peninsula of Hindustan and the island of Ceylon. With us, and with most Europeans, they are counted among the rest of the Hindu peoples, and called East Indians, but

they are a distinct race. In the hill regions there are scattered sporadically primitive Dravidians, like the Toda and the Gonds, the men of which, with their full, flowing beards and classical profiles, often resemble the Olympian Zeus.

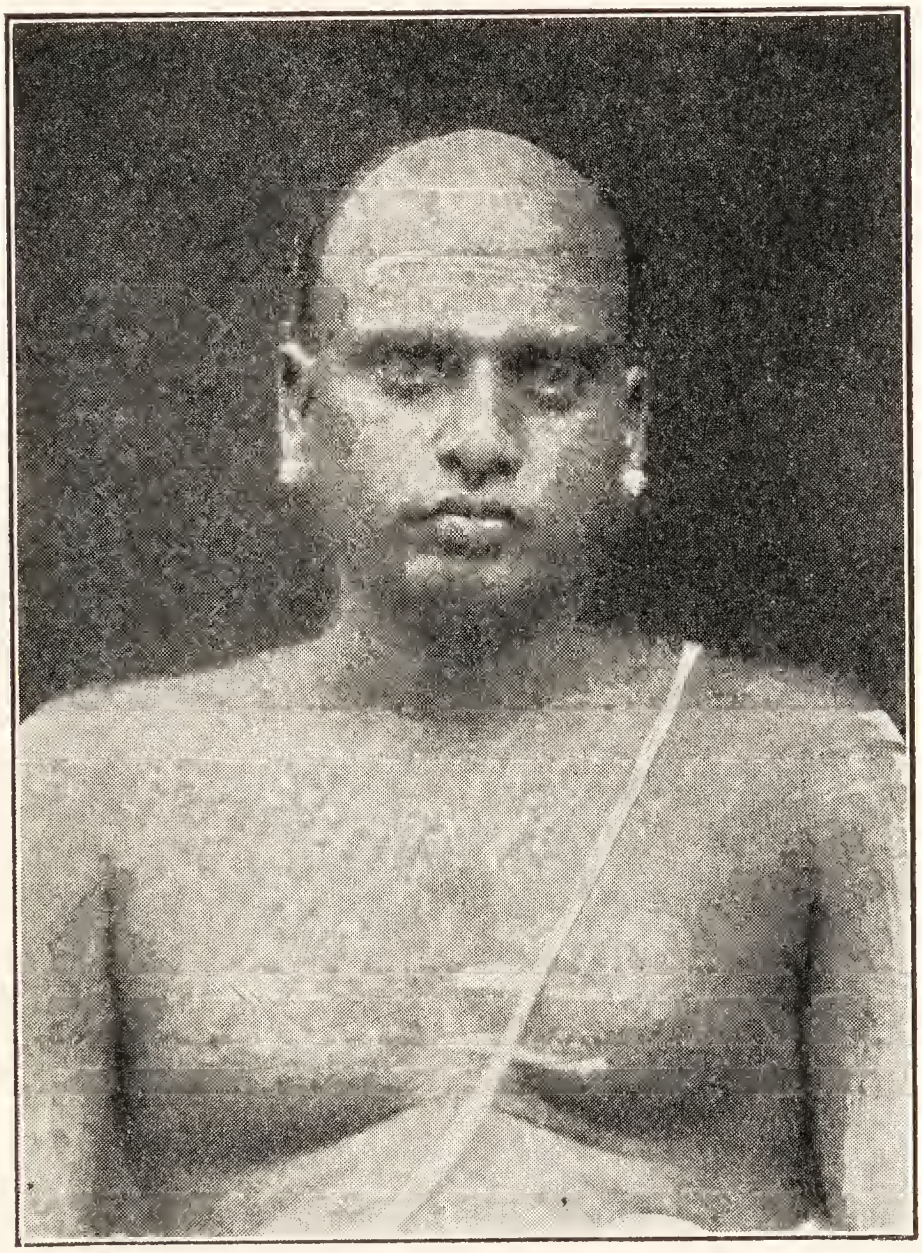


Fig. 105. A Tamil man from Jaffna, Ceylon.

More typical as examples of Dravidians are the Tamils, the principal stock of the island of Ceylon, which, although distinct from the Hindus, are still strongly Caucasoid. It is certainly a convenient solution of the difficulty to call them Proto-Caucasians.

Proceeding eastward, and keeping our eyes on the aborig-

ines, which often give us important clews to fundamental relations, and looking for Caucasoid characters, we come to the aborigines of the northern Japanese islands, Yezo and Sakhalin, where live the Ainu people. The Japanese have long considered the Ainu almost animals, and figure them as such in

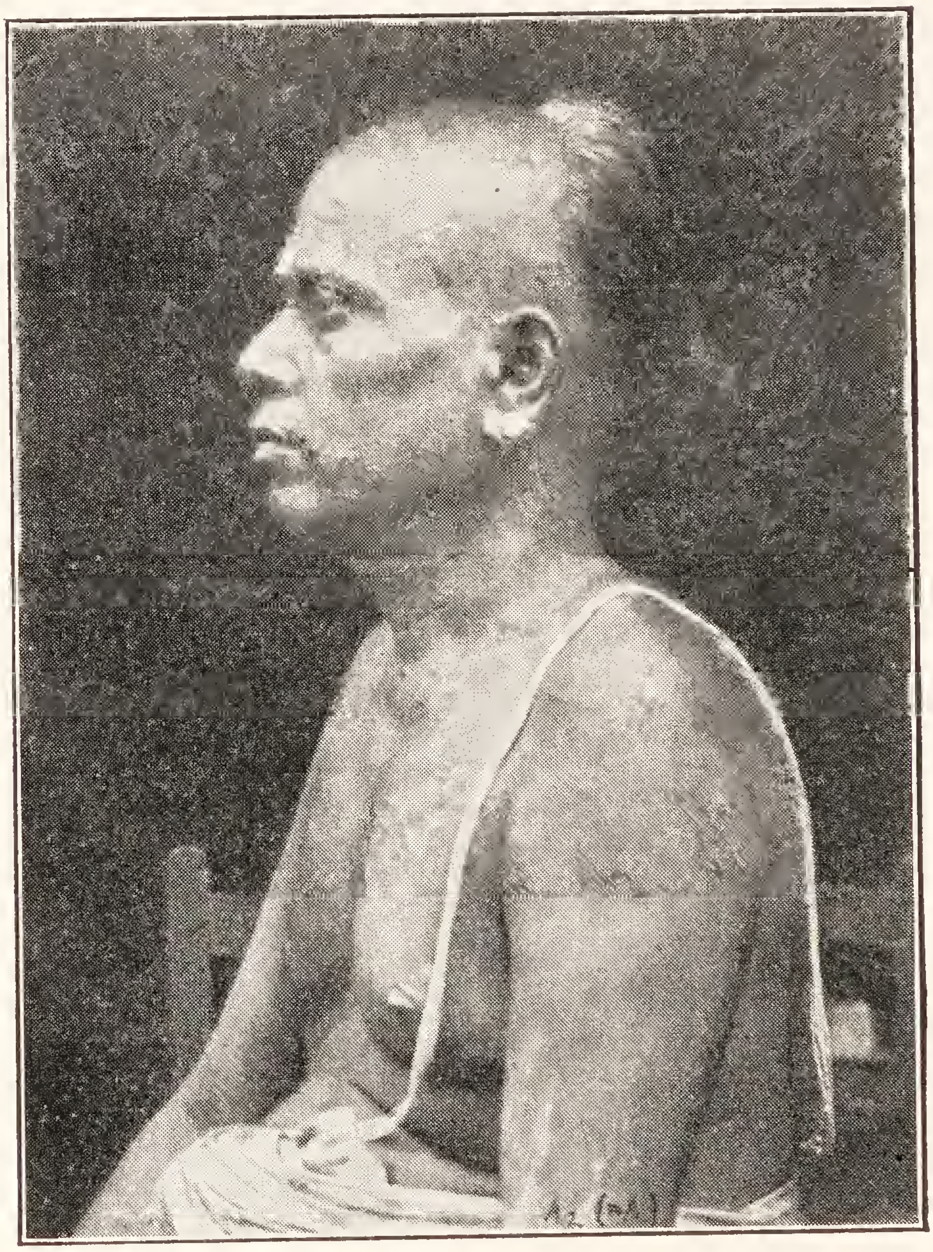


Fig. 106. Side view of the same man shown in Fig. 104.

their legends, but their hairiness has been much exaggerated at the hands of their smooth-bodied Mongolian neighbors, and they are in reality scarcely more so than may be often met with in members of the Leucodermic race in Europe or America. Some ethnologists see also in the Koreans a Caucasian stock that has lived long among Mongolian people, and is inclined to attribute their high success in

civilization to this strain. This smacks, however, too much of human prejudice, and is not what we would expect from our scientist from Mars, whom we are using as our ideal. Thus we are inclined to put the Koreans, with some regrets, back among their Mongolian neighbors, taking with us

FIG. 107. Side view of the same man shown in Fig. 105.

from this part of the globe merely the Ainus, as representatives from this region, of the Proto-Caucasians.

Coming to the Oceanic Islands, we find two very distinct stocks, the one Caucasoid, the other strongly Negroid, the Polynesians and the Melanesians. The dividing line between them may be drawn diagonally between Fiji and Samoa, leaving the former among the Melanesians, and the latter

among the Polynesians, with many mixtures along the borders. New Zealand and Hawaii are wholly Polynesian, and may be taken as types of these people, that is, Proto-

Fig. 108. A Tamil woman.

Caucasian, while as typical Melanesians are the Solomon Islanders, Proto-Ethiopians.

90. The Archimorphic Races: the Proto-Mongolians. Here belong all the peoples that are called "Malays," together with several peoples definitely allied to the Malays. In the past the separation of these peoples, and the attempt to make them coördinate with the Metamorphic peoples,

as Blumenbach tried to do, have resulted in great embarrassment, and it will seem much easier, and more in accordance with real relationships, if we can collect all these brown

FIG. 109. A Tamil woman from Jaffna, Ceylon.

peoples, under the head of Proto-Mongolians, and consider that they have some kinship with these, as the peoples just considered have with the Caucasians.

As previously we begin by searching for aboriginal peoples, still living in primitive conditions. These we can find in the interior of the larger East Indian Islands, the Dyaks in Borneo, the Battaks in Sumatra, the Igorotes in Luzon, and

so on. The more civilized peoples, called "Malays," live along the coasts of these same islands and represent a more differentiated portion of these same people. These are known as Visayans, Ilocanos, Tagalogs, etc., and are conveniently termed "Malays." Forming a fringe along the warmer

FIG. 110. Side view of the same woman shown in Fig. 108.

coasts we may follow Malays over a broad extent as far as the great island of Madagascar, where we find them again, or, at least, Proto-Mongolians, on the part of the Hova.

Closely related to Proto-Mongolians also there probably belong the aboriginal inhabitants of the Americas. We may suppose them the result of migrations of Mongoloid peoples from western Asia not so very long ago, as these people,

when first discovered by Europeans, were either Neolithic in culture or just entering the Age of Copper, suggesting their advent as approximately ten thousand years ago. There are many physical characteristics of these people similar to those of typical Mongolians, especially the straight

Fig. 111. Side view of the same woman shown in Fig. 109.

black hair and the skin color. The nose, too, which as a thin, rather prominent feature, appears at first as very unlike that of the true Mongolians, is a type occasionally met with in China. The physical characteristics of the American Indians, especially those of the face, are in places, as shown in the following brief summary, strikingly similar to those of the typical Mongolians. Because of their complete geographical

isolation, the American stock, though Mongolian in its affinities, has become more distinct than other Archimorphs, and thus may almost count as a fourth Metamorphic Race.

Skin color. Ranges from light to very black, in accordance with climate and altitude, although always with a reddish tinge, most commonly copper-red.

Pilosity. Scanty, almost beardless.

Hair of head. Long, straight and black, index of cross-section 77–83.

Head shape. Mostly mesocephalic, index 80–82. Some Eastern tribes are dolichocephalic, index 74–77. A few on the Pacific Coast are brachycephalic, index 84–85.

Eyes. Black or brown; The Mongolian type seldom occurs except among the Eskimos, where it is common.

Nose. Large and prominent but moderately thin, aquiline in profile. Index on skull 50, on living 75–80.

Mouth. In general, large. Lips thin, mucous surfaces not everted.

Distribution. Entire continents of both Americas.

91. The Archimorphic Races: the Proto-Ethiopians. We are in the habit of thinking of Africa as the home of the negroes, but black people with broad noses and woolly hair fill up the Melanesian part of Oceanica, and other Negroid peoples are found here and there on the mainland of Asia, and on scattered islands of the Indian Ocean. Indeed, there is even some doubt as to whether Africa was the original home of the Ethiopian Race, and whether we are not to look for the original race that first showed these highly differentiated characteristics either in Oceanica or among some of the other peoples which we now, at least for convenience, group together under the term of Proto-Ethiopians. It is certainly likely that, as in the case of the other Archimorphic groups, the first differentiation along this direction may have been among some of the peoples here included. We may

even suppose that at first all humanity was alike, and were Protomorphs, and that the three main stems of differentiation were for a long time not very widely dispersed, and thus not far removed geographically from each other.

92. Classified List of the Living Human Races. The above descriptive classification will be rendered clearer by adding the following list, which presents the same classification in another form. This is accompanied by a colored Plate, showing again the same thing in the form of a tree. In this latter there is no definite attempt to make a geographical division of the separate races, but when first drawing the different main branches it was noticed that, without definite intention, the branches were arranged in general like the continents. These were then separated by the dotted lines, while in a few cases the branches themselves were so arranged as to further this attempt. While, therefore, the diagram is intended primarily to show merely the probable blood relationships of the different races there has also developed to some extent the geographical relationships, although the diagram cannot be relied upon too far in this direction. For example, the Polynesians from the Caucasian stem and the Melanesians from the Ethiopian almost touch one another, showing the geographical relationships of these unrelated peoples. The Finns and Magyars are seen to arise from the Mongolo-Turki stock and pass over into Europe, where they come into close contact geographically with Caucasian peoples. The American branch, arising close to the Mongolian in the Old World, crosses over to the New, where it becomes differentiated geographically. The northern division meets in the far north a branch of the Mongolo-Turki, the Eskimo, distantly connected by blood. The Veddahs, although set down in the list as Proto-Caucasians, may be more synthetic than that, and better be treated as protomorphs, perhaps not the ancestors of all the main stems, like the Australians, but common ancestors

of all the others except the Ethiopians, which are not suggested by them. In the present state of our knowledge this and other similar theories can be no more than suppositions, but are suggestive and encourage further development of the subject.

I. *Protomorphic Races*

Australians

(The most primitive of living peoples, showing no characters that are specialized. Some have seen in them certain characteristics like those of *Homo neandertalensis* which would suggest that the present species (*sapiens*) may have been derived directly from them. Notable similarities are seen at once if we note the heavy, overhanging superciliary ridges, the low, slanting forehead, yet the Australians have projecting chins like other modern men, and the noses are flat and not prominent. On the whole, it is more usual to consider the Australians as typical men, species *sapiens*, of which they represent the most generalized type at the present day.)

It may be well to include as possible Protomorphs, some other primitive races, as the following:—

Veddahs
Koi-koin (Bushmen of South Africa)
Dravidians
American Indians (of which those of extreme South America are the most primitive)

II. *Archimorphic Races*

(*a*) Proto-Caucasians

Ainu (Yezo, Sakhalien)
Dravidians (Tamils, Singhalese, etc.) (Perhaps Protomorphs)
Hill tribes of India (Toda, Gonds, etc.) (Perhaps Protomorphs)
Veddahs (Perhaps Protomorphs)
Polynesians

(*b*) Proto-Mongolians
    1. Primitive Malays
        Igorote (Philippine Islands)
        Battaks (Sumatra)
        Dyaks (Borneo)
        Macassars (Celebes)
    2. True Malays (of the coasts)
        Tagalogs
        Visayans
        Ilocanos
        (and many others)
    3. Hova (Madagascar)

(*c*) Proto-Ethiopians
    Papuans
    Melanesians
    Negritoes
        Mincopies (Andaman Is.)
        Aetas (Luzon)
        Sakai (Peninsula of Malacca)
    Negrilloes—"Pygmies"
        Koi-koin—"Bushmen"
            (Perhaps Protomorphs)
        Akka, Batua, etc.
        Hottentot—Hybrid between Koi-koin and Bantu

(*d*) American
    (Perhaps Protomorphs or Proto-Mongolians)
    (These are all of one race; classified by geographical position, and by language. A few important divisions and subdivisions are as follows:)
    1. North America
        Algonquian
            Narragansett
            Wampanoag
            Nipmuck
            Passamaquoddy
            Pawnee
            Sacs and Foxes
            Virginia
            Mohicans

Iroquoian
- Mohawk
- Seneca
- Onondaga
- Oneida
- Tuscarora

Caddoan
- Cherokees
- Creeks
- Catawbas
- Dakotas (Sioux)

Athapascan
- Bella Coola
- Haida
- Thlinkit
- Apache

2. Central America
   - "Aztec" = Nahua (Mexico)
   - Tarascon (S. Mexico)
   - Maya (Yucatan)
   - Caribs (W. Indies, etc.)

3. South America
   - Botocudo (Amazon)
   - Quichua (Peru)
   - Tehuelche (Patagonia)
   - Fuegians (Tierra del Fuego)

III. *Metamorphic Races*

(These are the most distinct, most highly specialized peoples. They may be supposed to have been derived from generalized Protomorphs, the wild Human stock. All these have specialized along definite directions, modifying the characteristics which they had at first in adaptation to the physical-geographical conditions which they met with, the results being as we find them)

A. *Caucasians* (Leucoderms)

(*a*) *Mediterraneans*

Libyans
Pelasgians
Ligurians
Iberians

(*b*) *Semites*

Arabs
Syrians
Jews

(*c*) *Indo-Iranians*

Armenians
Kurds
Caucasians (Georgians, Circassians)
Persians
Afghans
Beluchis
Hindus

(*d*) *Aryans* (Alpines)

Kelts
Germans
Slavs

(*e*) *Nordic*

Scandinavians
Teutons (North Germans)
Belgae (of Caesar)
Frisians—of medieval times
Saxons " " "
Franks " " "
Goths " " "

B. *Mongolians* (Xanthoderms)

(*a*) *Sibiric*

Manchu
Kalmuk (Mongol, etc.)
Tartaric (Turki)
Finnic
Arctic (Eskimo)
Korean
Japanese

(*b*) Sinitic (i. e., Chinitic)
- Chinese
- Tibetan
- Indo-Chinese (Anam, Siam, Burma)

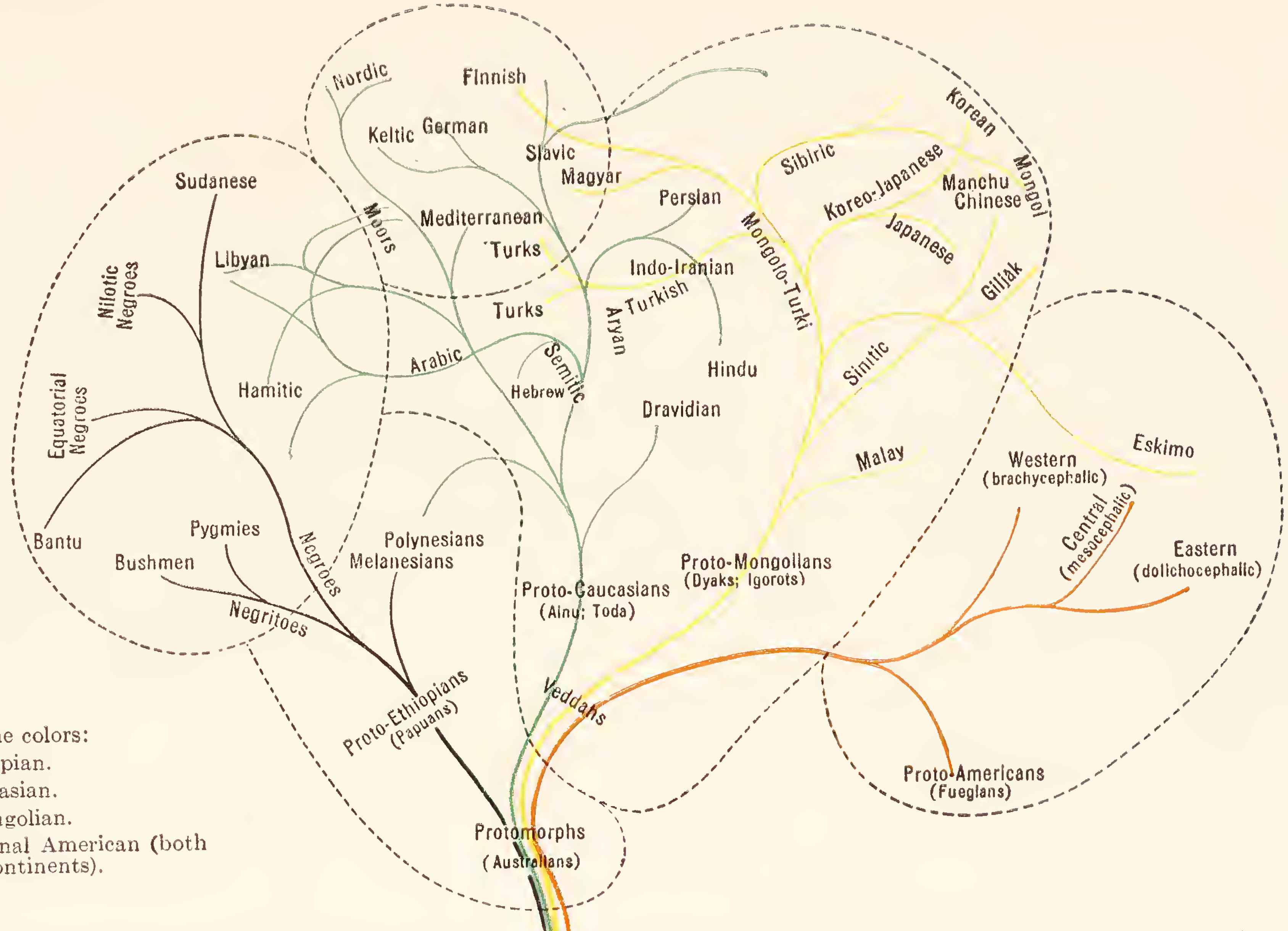
C. *Ethiopians* (Melanoderms)

(*a*) *Sudanese negroes*
- Yoruba
- Haussa
- Guinea negroes

(*b*) *Nilotic negroes*
- Dinka
- Shilluk

(*c*) *Equatorial negroes*
- Niam-Niam (Fans)

(*d*) *Bantu negroes*
- Ba-ganda
- Ba-suto
- Ba-suahili
- Ama-zulu
- Ovo-herero, etc.



Significance of the colors:
Black = Ethiopian.
Green = Caucasian.
Yellow = Mongolian.
Red = aboriginal American (both continents).

Phylogenetic tree, showing the author's conception of the main races of men, and their interrelationships. This is shown in the usual form of a tree, in which the three main human races, together with their allies, are expressed in different colors. The aboriginal Americans, which are considered by some as distinct, and by others derived from the Mongolian stock, are given a distinct color. It is to be noticed that the native Australians (Protomorphs) are placed at the base of the tree, and embrace all four of the main stems. The Veddahs, almost equally primitive and synthetic, embrace all of the main stems except the Ethiopians, no features of which show among their characters, giving them a position ancestral to the Caucasians, Mongolians, and of course the aboriginal Americans.

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